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RADIUM TREATMENT

of

SKIN DISEASES, NEW GROWTHS

DISEASES OF THE EYES

AND TONSILS

FRANCIS H. WILLIAMS, M.D.

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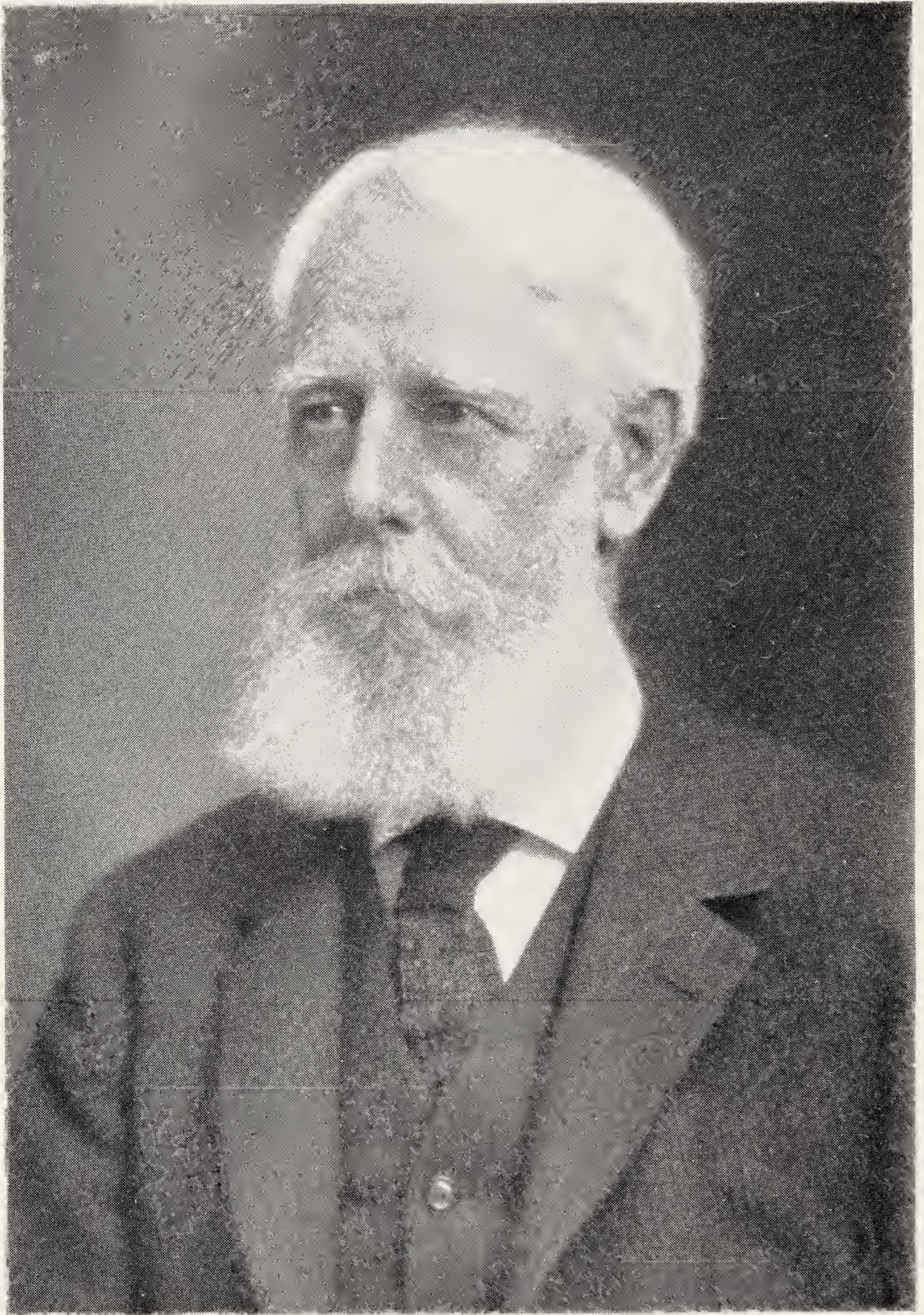


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RADIUM TREATMENT

OF

SKIN DISEASES, NEW GROWTHS,
DISEASES *of the* EYES, *and* TONSILS

BY

FRANCIS H. WILLIAMS, M.D. (Harv.)

S.B. Massachusetts Institute of Technology; Senior Physician Boston City Hospital; Fellow American Academy of Arts and Sciences; Emeritus Member Association American Physicians; Member Société de Radiologie Médicale de France; Corresponding Member K. K. Gesellschaft der Aerzte in Wien; Honorary Member American Radium Society, American Roentgen Society, Radiological Society of North America, etc. Author: "The Roentgen Rays in Medicine and Surgery" (3 editions), 1901-1903

With twelve illustrations



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PREFACE


This book is the result of thirty years' experience in the use of radium.

The method described is based upon measurements of the absorption of the radiations by different substances to be used as filters, and by different thicknesses of water as a standard for the absorption by the soft tissues of the body, thus making possible the selection of the amount and quality of the radiations best suited to a given condition.

I wish to express to my secretary, Mrs. William Jordan Anthoine, my appreciation of her assistance in the preparation of this book.

FRANCIS H. WILLIAMS

505 Beacon Street
Boston, Massachusetts
May, 1935



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Table of Contents

PART I

I.	Nature and Properties of Radium	3
	Discovery of radium—Physical properties of radium—Experiments with beta and gamma rays—Comparison of radium and Roentgen rays—Radium as a therapeutic agent.	
II.	Measurements	13
	Fluorometer—Measurements in vacuum—Water as a standard for absorption by the soft tissues of the body—Prescription for use of radium.	
III.	Method of Using Radium	20
	Container—Method of treatment—Length and frequency of treatment—A method of using radium radiations for superficial lesions.	
IV.	Radium in Diseases of the Skin and Superficial New Growths	24
	Diseases of the skin—Melanotic sarcoma—Rodent ulcer—Epithelioma—New growths of glands, tongue, mouth or tonsils—Radium after other forms of treatment—Radium in recurrences—Radium treatment of epitheliomas resulting from Roentgen ray burns—The gamma rays as an analgesic.	

PART II

DISEASES OF THE EYES AND EYELIDS

I.	Diseases of the Eyes	37
	Results of radium treatment by Sir J. Mackenzie Davidson—Field of radium in diseases of the eyes.	

II.	Instruments	40
	Container—Lid retractors—Quartz lamp.	
III.	Method of Treatment	43
	Measurements—Selection of suitable radiations —Illustrative case.	
IV.	Diseases of the Eyelids	46
	New growths—Ectropion.	
V.	Opacities of the Cornea	48
	First successful use of radium in 1904—Resist- ance of normal cornea to radiations—Illustra- tive cases—Summary.	
VI.	Cataract	54
	Usual treatment—Radium treatment—Meas- urements of absorption in different parts of the eye—Anterior capsular cataract—Filters—Il- lustrative cases—Economic value of radium treatment—Diabetic patients—Summary.	
VII.	Retinitis Pigmentosa	62
	Diseases of the eyes resulting from infected tonsils.	

PART III

TONSILS AND OTHER LYMPHOID TISSUE IN THE THROAT

I.	Infected Lymphoid Tissue in the Throat	67
	Tonsils as a source of infection—Results of radium treatment not due to bactericidal action —Prevalence of infected tonsils—School chil- dren and industries—Heart disease and rheu- matic fever.	

TABLE OF CONTENTS

iii

II.	Other Forms of Treatment	73
	Tonsillectomy—Comparison of tonsillectomy and radium—Comparison of Roentgen rays and radium.	
III.	Precautions	76
	Measurements — Limitation of radiations — Adaptability and safety of method.	
IV.	Instruments	79
	Container—Lamp—Laryngeal Mirror—Tongue Depressor—Timing Exposures.	
V.	Treatment.	83
	Method of applying radium—Treatments—Treatment in acute conditions—Discharge from the tonsils—Prompt improvement after radium treatment—Treating children—Applying radium through the skin—Permanency of results—Illustrative cases—Palpation—Fibrous tonsils—Arthritis—Illustrative cases—Hay Fever—Radium treatment of tonsils after tonsillectomy and tonsillotomy—Lymphoid tissue in the pharynx—Lingual tonsils—Eustachian tube—Other methods of applying radium to the tonsils—Safety of radium.	
	Bibliography	112
	Index	115

LIST OF ILLUSTRATIONS

FIG.		OPP. PAGE
	Dr. Francis H. Williams . <i>Frontispiece</i>	
1.	Eye instrument	40
2.	Method of applying radium to the eyes	42
3.	Curve showing absorption of electrons by mica	44
4.	Test type	50
5.	Opacity of cornea after treatment with radium	52
6.	Tonsil instrument	78
7.	Laryngeal mirror	80
8.	Tongue depressor	82
9.	Method of applying radium to the tonsils	84
10.	Method of holding diaphragms . .	86
11.	Instrument for treating Eustachian tube	108
12.	Curve showing absorption of electrons by platinum	110

PART I

NATURE AND PROPERTIES
OF RADIUM

MEASUREMENTS

RADIUM IN DISEASES OF THE
SKIN AND SUPERFICIAL
NEW GROWTHS

NOTE : Superior figures in text refer
to Bibliography on pages 112-114.



CHAPTER I

NATURE AND PROPERTIES OF RADIUM

Discovery of Radium. The discovery of the Roentgen rays in 1895 was followed by that of the Becquerel rays in 1896. Becquerel found that uranium and its compounds emitted rays that acted upon photographic plates enclosed in paper envelopes, and rendered gases through which they passed, air for example, better conductors of electricity. To substances that gave out radiations of this character Mme. Curie gave the name "radio-active," and she demonstrated that the radioactivity of uranium and its compounds was an atomic property. Believing that this property belonged to more than one class of matter, she tested a large number of metals, metalloids and minerals, and compared their radioactivity with that of uranium.

In 1898, in the course of this investigation, she found some minerals, among others pitchblende, that were much more radioactive than was to be expected from the uranium present in them, and she inferred that they must contain in small quantities a new substance that was intensely radioactive. After long and careful work, in con-

junction with M. Bémont, Professor and Mme. Curie succeeded in extracting from pitchblende the substance to which they gave the name radium. Later Mme. Curie isolated the pure chloride of radium and determined the atomic weight of radium as 225, a figure which she considered exact within a unit; it was afterwards found to be 226.5.

The salts only of radium—bromide, chloride and sulphate—are used, metallic radium being unstable in the air. The radioactivity of different qualities of radium salts is indicated by comparison with that of uranium as a unit; radium having a radioactivity of 1000 is 1000 times more radioactive than uranium. Pure radium salts are said to have a radioactivity of about 1,800,000.

Physical Properties of Radium. Radium has five properties that especially deserve notice, which obtain constantly without appreciable loss of weight:

First, it maintains a temperature above its surroundings under thermal insulation; a temperature of 1.5° C. has been observed.

Second, it is luminescent.

Third, it is a spontaneous source of electricity.

Fourth, it gives out three kinds of rays, named by Rutherford, alpha, beta and gamma; the alpha rays are now called alpha particles, and the beta rays are known to be electrons.

Fifth, it produces in surrounding objects what Mme. Curie called "induced radioactivity," Rutherford termed "excited radioactivity," and Soddy designated as "imparted radioactivity."

The alpha particles constitute the largest part of the radiation and are slightly deflected by a strong magnetic field. The electrons are more strongly deflected by the magnetic field than the alpha particles and in a different direction, but in the same direction as the cathode rays. The gamma rays are not deviated by the magnetic field. A knowledge of the physical properties of radium salts forms a necessary preliminary to their intelligent use in medicine. For medical purposes we have to consider only the electrons and the gamma rays, since the penetrating power of the alpha particles is so slight that the cover of any container would absorb them. The radiations continue spontaneously, and fortunately with so little deterioration as to be negligible, a loss of only 5 per cent. in one hundred years.

In 1900 my attention was directed to radium by Dr. William Rollins of Boston, who put into my hands a capsule containing chloride of radium, with the suggestion that I use it for therapeutic purposes. The salts then available were not powerful enough to be efficient and no definite results were obtained, but to Dr. Rollins belongs the

credit of being the first, so far as I am aware, to realize the probable value of these radiations as a therapeutic agent.

In 1902 I used some of these salts in an instrument, which I devised for measuring the Roentgen rays and called a fluorometer.*

In 1903 I went abroad and brought home 20 milligrams and two capsules of 50 milligrams each of pure radium bromide, one of which was used in my private practice and the other at the Boston City Hospital. Through the kindness of Dr. A. Béclère in Paris, I also obtained what was invaluable, a copy of Mme. Curie's thesis to the Faculty of Sciences in 1903, "*Recherches sur les Substances Radioactives.*"

In order to use any remedy safely and intelligently, its properties and dosage should be known, but this is far more important when we have to deal with an agent, such as radium, which gives out remedies of more than one kind, some of which should not be used in certain conditions, but would be indispensable to the successful treatment of others.

Experiments with Beta and Gamma Rays. Before using radium it seemed to me important to make a study of the beta† and gamma rays.^{6 7} The

*Described on page 641 of the third edition of my book, "The Roentgen Rays in Medicine and Surgery."

†At this time the beta rays were not known to be electrons.

experiments* were made in a dark room with one of my specimens of 50 milligrams of pure radium bromide. To learn whether or not the beta rays could penetrate deeply, I first separated them from the gamma rays by means of an electromagnet, then placed the end of my little finger in their path, and found that even the flesh of the finger cast a marked shadow on a barium-platino-cyanide screen. This experiment showed that most of the beta rays are absorbed near the surface. While the beta rays were deflected, I put in their path a sufficient thickness of aluminum to absorb them wholly; with the gamma rays alone I found that aluminum of several times that thickness cast no appreciable shadow upon the fluorescent screen. In this way I learned the thickness of aluminum required to cut off the beta rays from this specimen of radium, while allowing the gamma rays to pass. This enabled me to use either the rays that act on or near the surface, or those which penetrate more deeply. Further experiments showed that practically all of the beta rays were absorbed by a thickness of $2\frac{1}{2}$ cms. (1 inch) of soft tissue, and that most of them were absorbed by one-half this thickness. Clinical tests indicated that the beta rays had the chief therapeutic value. They do not

*I had the privilege of making these experiments in the Lowell Laboratory of Electrical Engineering at the Massachusetts Institute of Technology.

penetrate deeply, but may eventually reach the deeper portions of a new growth by first destroying the outer portions layer by layer and then attacking the parts that in the beginning were more than a half inch from the surface.

In order to test further the penetrating powers of the beta and of the gamma rays, I placed a barium-platino-cyanide screen on one side of the body and 50 mgs. of pure radium bromide on the other and found that the gamma rays alone made the screen fluorescent; this fluorescence was greatly increased by the addition of another 50 mgs. of pure radium bromide, but the illumination of the screen seemed to be the same whether the gamma rays were used alone or with the beta. This experiment showed that the gamma rays can pass through the thickest parts of the body.

Test of Healing Power of Gamma Rays. Another question to be answered was whether or not the gamma rays healed; to do this it was necessary to learn the proportion of beta and gamma rays given off by the radium salts, in order to know what exposure to make. By means of my fluorometer,⁶ I found that there were at least fourteen times as many beta as gamma rays; therefore, it seemed that when the gamma rays alone were used, the exposure should be longer

than when the beta and gamma rays were used together.

To test the healing power of the gamma rays, I exposed certain small areas of psoriasis to the beta and gamma rays together for two minutes each; then I shut out the beta rays and exposed other areas on the same patient to the gamma rays alone, making the exposures fifteen, thirty, and forty-five minutes, respectively. A week later the areas that had been exposed to the beta and gamma rays together had improved very much, while those that had been exposed to the gamma rays alone showed no change in appearance. All the areas that were subjected to the action of the beta and gamma rays together healed after one or two treatments, whereas those exposed to the gamma rays alone did not heal. As no irritation resulted from exposures to the gamma rays more than twenty times as long as those given with the beta and gamma rays together, it was inferred that the beta, rather than the gamma rays, are the ones which cause the burns.

*Comparison of Radium and Roentgen Rays.*⁸
The radiations from radium, unlike the Roentgen rays, can not be used for diagnosis or prognosis, either by means of radiographs or the fluorescent screen, because of their inability to show sufficient differentiation between the tissues.

Radium as a therapeutic agent has certain advantages as compared with the Roentgen rays. Obviously, a few milligrams of radium salts offer a far more convenient source of radiation than a cumbersome Roentgen ray apparatus. Radium is always ready for use, and the amount of radiation is uniform, so that, without the necessity of measuring the output, as in the case of a Roentgen ray tube, the dosage can be regulated exactly in either of two ways, by varying the length of exposure, or by varying the distance of the radium from the patient. Radium may be applied to parts which are not readily accessible to the Roentgen rays. The healing action of radium is more prompt, therefore the treatment extends over a shorter period, and fewer exposures are required than when the Roentgen rays are used. Radium has the further advantage of bringing about healing in some cases where the Roentgen rays have failed after careful and long continued treatment. In a general way, it may be said that radium is better adapted to somewhat limited areas rather than to the larger ones, which may be easily covered by the Roentgen rays at one exposure.

On the other hand, there is much similarity between the action of the radiations from radium and the Roentgen rays, and the two may supple-

ment each other. For example, a disease that has attacked different parts of the body of a given patient may be better treated in certain regions by radium and in others by the Roentgen rays. It is quite possible that in some cases the two remedies used together on the same area and at the same sitting may accomplish better results than either alone.

The use of radium salts for therapeutic purposes requires much the same kind of experience as is essential for the successful therapeutic use of the Roentgen rays. As with the Roentgen rays, caution must be observed when treating patients, for the sake both of the patient and of the practitioner, for radium, if not properly protected, may cause severe burns, which do not manifest themselves for a week or more. These burns are painful and heal slowly. Radium, therefore, should be kept in a metal container with a thin mica front, or other suitable covering, so that the radiations may be cut off in all directions except that in which the practitioner desires the rays to proceed.

In 1903 I measured the radiations from radium⁶ and demonstrated their value as therapeutic agents.⁷ These patients included 1 case of acne, 2 of eczema, 2 of psoriasis, 4 of lupus vulgaris, 1 small keloid, 5 cases of rodent ulcer, 23 of epi-

dermoid carcinoma, and 4 breast cases. All of these with the exception of one of the breast cases, were healed or improved by the use of radium. In the cases where the Roentgen rays had been used previously, improvement was more rapid after radium treatment. The results in these 42 cases showed that radium was useful for treating some skin diseases and superficial new growths.

CHAPTER II

MEASUREMENTS

The radiations from radium

First, act upon a photographic plate.

Second, ionize the air.

Third, cause fluorescence in certain substances, particularly tungstate of calcium.

The property of causing fluorescence is the basis of the method chosen for the measurements here presented.

Fluorometer. The instrument, a modification of the one used in making my early measurements, consists of two similar tungstate of calcium screens, one of which, the standard for these measurements, is made fluorescent by the radiations from 2 mgs. of radium element precipitated with 25 mgs. of calcium carbonate, contained in a shallow cell, 4 mms. x 25 mms., just sufficiently deep to hold it, and covered by a thin layer of mica over which is a plate of aluminum 2 mms. thick. The distance of this radium from the standard screen, 6 cms., gives what has been found to be a convenient amount of fluorescence. On the same piece of cardboard and 2 cms. from the first screen, is the second which is made fluorescent by

the radium salt to be tested. Each screen is protected by lead in a way to prevent the radiations intended for one from falling upon the other, and the lead, the standard radium, and the two screens are mounted upon a block of wood which may be slid along a centimetre scale. Screens of uniform quality can now be obtained.

The radium to be tested is placed at the zero end of the scale and the two screens are moved to the point where the one made fluorescent by the radium has the same brightness as the standard screen. This distance is then measured and squared and the square constitutes a reading. Different thicknesses of different metals, or of other substances, may be placed in front of the radium, and from the readings the proportions which they absorb may be ascertained. These measurements may be plotted on curves, the readings forming the ordinates and the thicknesses of filters the abscissae. (See Fig. 3.)

The measurements must be made in a dark room, in which the observer has remained for twenty minutes, in order that his eyes may be in a proper condition for comparing the brightness of the two screens. The accuracy of the measurements may be checked by letting the light from a flashlight fall for a moment upon the wall, while the observer is looking in the direction of the

screens, which at first will not be visible. If the reading is correct, they will reappear at the same instant; if they do not, the reading is incorrect and must be repeated. A small flashlight may also be used to read the centimetre scale.

Measurements in Vacuum. Clinical use suggested that certain of the radiations acted more energetically than my measurements had indicated; it was, therefore, inferred that some of the radiations were absorbed in the air. To test this, I devised a way of making the measurements in vacuum, and found a larger proportion of the radiations of slower speed than when the measurements were made in the air.

The instrument consists of a glass tube 5 cms. in diameter and $1\frac{1}{4}$ ms. long, sealed at one end. The other end is closed by a large rubber stopper, which carries the radium, and above it a clamp from which may be suspended, in front of the radium, plates of metal or other substances. A small glass tube, about 4 cms. long, on the side of the large tube, connects it with an air pump by means of heavy rubber tubing. Inside of the long tube is a piece of thin brass tubing 5 cms. long, which carries the fluorescent screen, and is a little smaller in diameter than the interior of the glass tube, so that when the latter is inclined and tapped with the finger the screen will slide in either direc-

tion. On the outside of the glass tube is a paper centimetre scale. For convenience the tube rests on a board about 14 cms. wide and 1 m. long, to which the first tungstate of calcium screen, and the lead with the 2 mgs. of radium, are attached.

To use the instrument, the radium in its container is fastened to the inside of the rubber stopper, which is then inserted into the glass tube. After the air in the tube has been pumped out to a pressure of about 2 mms., the fluorescent screen inside is slid to a point where it has the same brightness as the standard screen. When this point is reached, the distance of the second screen from the radium is read on the centimetre scale on the side of the tube.

After each separate reading, the air is allowed to re-enter the tube, the rubber stopper withdrawn, then another substance may be put in front of the radium, the stopper replaced, the air pumped out, and readings made as before.

Water as a Standard for Absorption by the Soft Tissues of the Body. For clinical purposes, the proportion of rays absorbed by different thicknesses of tissue, as well as the amount absorbed by different thicknesses of screens or filters, such as aluminum or mica, must be known. To estimate the amount of radiation absorbed by most of the soft tissues, assuming that water corresponds, in

its absorption of the electrons, to these tissues, different thicknesses of water are placed in front of the radium to be tested. While water has not exactly the same degree of absorption as the tissues, it answers the purposes of a standard.

For measuring the absorption by the soft tissues, using different thicknesses of water as a standard, brass plates 5 cms. (2 inches) long and 4 cms. ($1\frac{1}{2}$ inches) wide, with an opening in the centre 18 mms. ($\frac{3}{4}$ inch) in diameter, are used. From the opening to the upper edge of the middle plate is a slot 6 mms. ($\frac{1}{4}$ inch) wide; on each side of this plate is placed a sheet of celluloid 0.15 mm. thick, the outer plates are then put over each of these sheets, the three plates held firmly together by rubber bands, and the cell filled with water. The thickness of water is the same as the thickness of the middle metal plate.

The measurements are made by means of a glass tube similar to the one described on page 15. from which the air has been pumped out and the tube sealed. This tube also contains a sliding fluorescent screen, and has at one end a window 0.2 mm. thick, through which the readings are made, allowance being made for the thickness of the glass window and of the two sheets of celluloid which form the walls of the water cells.

These measurements give the proportion of the

radiations coming from a specimen of radium under different conditions; the actual amount of radiation would depend upon the quantity of radium. While the measurements have not the accuracy which a physicist might demand, they are sufficiently accurate for clinical purposes. What is required is a method which will enable practitioners to repeat what has been done before, or to modify it as desired. A prescription might read, for example:—

R/x

Amount of radium element	25 mgs.
Filter	.2 mm. aluminum
Distance	1 cm.
Time	5 minutes

The electrons are given off at various speeds, and penetrate the soft tissues to different depths, up to about 15 mms. By using all of the radiations for a short time, the least penetrating rays, since they are present in far larger proportion, will do their work so quickly that the more penetrating and less numerous of the electrons would have but little action. When deeper parts are to be treated, the less penetrating rays should be absorbed by interposing a plate of some substance, such as aluminum or mica, and the treatment should be of longer duration.

In order to make the field of usefulness of the

electrons as large as possible, it is essential to be able to choose, so far as may be, from among all kinds of these radiations, from those which would be absorbed by a thin sheet of rubber to those which would penetrate through 15 mms. ($\frac{5}{8}$ inch), more or less, of water.

It is well known that various tissues react differently to the radiations. Tissues, such as fibrous tissue, which do not reproduce themselves rapidly, are more resistant than those which have this property. Among pathological tissues, some yield more readily than others.

The measurements described form a basis for the safe and intelligent use of radium. No arbitrary directions can be given; the successful application of what is here presented requires experience and judgment on the part of the practitioner.

CHAPTER III

METHOD OF USING RADIUM

Container. The container, a disk of gold, about 6 mms. ($\frac{1}{4}$ inch) thick and about 12 mms. ($\frac{1}{2}$ inch) in diameter, in which the radium lies in a depression 8 mms. ($\frac{5}{16}$ inch) in diameter and just sufficiently deep to hold 26 milligrams of radium element in the form of bromide,* covered with a plate of aluminum 0.29 mm. thick, is on the end of a metal rod about 30 cms. (12 inches) long and 3 mms. ($\frac{3}{32}$ inch) in diameter. When not in use the radium is protected by a disk of gold 5 mms. thick inserted in place of one of the diaphragms. (See Fig. 10.)

Method. The method of using the radiations from radium is simple. If the strongest action of the radium is desired, the container is placed on the part to be treated, after having been covered with a thin rubber cot, or other suitable substance which can readily be removed, so that a new cot may be used for each patient and the old one destroyed; thus the radium container is separated from the part to be treated by this new and clean

*Since the percentage of radium element varies in the different salts, the size of the cell should be adapted to the salt employed.

covering. If a weaker action of the radium salts is indicated, the container should be held at a greater or less distance, according to the requirements of the case, the intensity of the radiations diminishing as the square of the distance. Filters of aluminum or mica are used to shut out the radiations which should not be used in certain conditions, and diaphragms of different sizes and shapes are used to limit the spreading of the radiations, and also to employ different amounts of radium element from the same container. No pain accompanies the treatment, and there is no sensation except that produced by the contact of the rubber covering the radium.

As a protection to the surrounding parts, from one to three thicknesses of $\frac{1}{2}$ -inch ZO adhesive plaster, cut in lengths of about $\frac{3}{4}$ -inch, in order that they may be fitted about an irregular shaped lesion, may be placed around the area to be treated, in some cases close to the edge and in others leaving a margin of $\frac{1}{16}$ inch or more, according to the size of the area to be exposed to the action of the radium.

Length and Frequency of Treatment. Treatments must in some cases be longer, in others shorter, and the frequency with which they are given must vary. In some cases the treatment should be pushed; in others harm rather than good

would result from this procedure. The exposures differ for different diseases, and must be adapted to the special case. Not more than two applications should be made a week, thus progress can be watched during the interval. The duration may vary from two or three to ten minutes according to the extent and depth of the disease, the radium being moved about so that all parts are reached. In some cases the length of treatment may be a half hour or even more, but this does not apply to the early cases of small area. It is important to remember that overexposure of a part may result in a burn, which may not become evident for some days after the exposure has been made.

If weak forms of radium are used, a long exposure is necessary, and these weaker forms would not be efficient as compared with the pure salts. Pure radium salts are none too strong for the treatment of certain cases; if the full strength is not necessary, the radium container can be held at any distance desired, and the exposure can be shortened, or the amount of radium element may be reduced by using a diaphragm with an opening of smaller diameter.

A Method of Using Radium Radiations for Superficial Lesions. While studying the radiations from radium I observed that when a lead plate was placed in their path, the rays arising from the

plate were in greater amount when they struck it at an angle between 45 and 50 degrees. This led me to attempt to make use of these observations for medical purposes by placing the radium inside of a lead cone, the interior of which was so shaped that many of the rays struck it at about these angles. Tests made by both photographic and ionization methods showed that this increase was due to the less penetrating rays and that the amount of gamma rays was diminished. By the use of this cone the amount of radiation available from a given amount of radium is increased, thus a larger area of a superficial disease can be treated at one time and the amount of gamma rays, which can not be excluded by filters, is diminished.¹⁵

CHAPTER IV

RADIUM IN DISEASES OF THE SKIN AND SUPERFICIAL NEW GROWTHS

The value of radium in certain skin diseases, such as acne, eczema, psoriasis, angioma, nevi, keloids, moles, warts and warty growths, keratoses, and early superficial epitheliomas, is now well established. It has also been successful in the treatment of callus, corns, cornu cutaneum, hem-angioendothelioma, and lupus. All of my cases of lupus vulgaris have done well. In two of them a comparison was made between radium and the Roentgen rays by treating one-half of a considerable area with the Roentgen rays and the other half with radium; the radium proved to be more efficient than the Roentgen rays.

Skin lesions should not be neglected; though they may lie dormant for a time, they may, on the other hand, if left untreated, lead to serious trouble by becoming irritated, or from some other cause. Anything which might give rise to an epithelioma, such as a wart which has been irritated or torn off, or a small intractable spot of apparent eczema, or other starting points of epithelioma which do not heal in a few weeks or months should

be submitted to treatment by radium. Many surgeons advocate operation for any skin lesion which might be suspected of being or becoming malignant; since many of these small lesions heal under radium, this painless remedy should be used first.

Melanotic Sarcoma. Of four patients with melanotic sarcoma, three healed, and the fourth, an elderly woman who came from another city, improved but discontinued treatment before complete healing had been accomplished.

Rodent Ulcer. In 1908 I reported the results of radium treatment of rodent ulcer and epithelioma.¹⁰ Of 17 cases of rodent ulcer, 11 healed, 1 healed but recurred later, 4 did not heal, and 1 was still under treatment. The average duration of the disease before treatment was begun was ten years. I believe that better results might have been obtained if patients had come earlier and if the radium had been used more vigorously.

Epithelioma. Of the 69 cases of epithelioma in this series, the average duration of the disease before treatment was begun was four and one-half years. 56 healed, 1 did not heal, 4 were under treatment, and 8 discontinued treatment, but these last, with one exception, were doing well at the time. Of the 56 healed cases, 23 had been well for two years or more, 9 of these 23 for more than three years, and 2 for more than four years.

Recurrence took place in 2 of the 23 cases, in one a year and in the other two and one-half years after healing, but yielded to further treatment. These 69 epitheliomas did not include pre-epitheliomatous growths.

“Let me describe one case. This patient had a typical epithelioma of the lip about $\frac{1}{2}$ -inch in diameter in the mucous membrane of the lower lip not far from the median line. It had begun slowly with a little roughening and irritation of the mucous membrane; this spread and later the disease progressed more rapidly. Various powders and other simple forms of treatment had been used for more than a year after the first symptoms appeared. At the end of this time the patient came to me for radium treatment and all other treatment was omitted. The treatments were given twice a week for six weeks. Three days after the first treatment the crust came away leaving a rough surface containing holes as if roots had been drawn out. A week later these openings had filled up and the induration had disappeared. After ten days the ulceration was less indolent in appearance. After fourteen days there was a clean, oval ulceration with a narrow, contracting circle of scar tissue around the edge. After seventeen days the appearance was that of a healing ulceration and the induration had nearly if not quite disappeared.

All this improvement took place after only five treatments of three to four minutes each, and was so rapid that some improvement was noticeable at every visit. When healing was complete, at the end of six weeks, the mucous membrane of the lip where the epithelioma had been did not differ in appearance from that of other parts, but there was a slight depression as a result of the loss of substance."

In another case of epithelioma of the lip, a gland, just under the angle of the jaw, which became somewhat enlarged, four months after the lip had healed, was removed, and was reported by the pathologist to be cancerous. No recurrence took place on the lip. This case showed that the action of radium was local, and indicated the importance of its early use. When desirable, radium may be supplemented by suitable treatment of the neighboring glands.

At this time I made the following statement:

"In epitheliomas of short duration the *improvement* seems to be prompt. By this I mean the sensation and soreness diminish or disappear and the diseased area becomes less aggressive and the disease appears to be arrested in its progress in two or three weeks, and sometimes less. When we consider

First, that epitheliomas may begin to improve promptly,

Second, how well they have healed when properly treated with a suitable amount of pure radium bromide, and

Third, that speaking generally epitheliomas that have not been operated upon seem to do better when treated with radium than those upon which an operation has been performed and then radium treatment begun,—

I believe that radium should be employed in early epithelioma before any other treatment is used.”

In 1913 a series of 181 cases of skin cancer was reported, where the treatment was begun before December 31, 1909.²¹ These cases were consecutive with the exception of five which were omitted because they were beyond the reach of any remedy and radium was used as a palliative only. The ages of the patients varied from twenty-four to ninety-one years. 154 healed, 7 did not heal, 3 were under treatment, and 17 discontinued treatment, of these 9 were improving.

The duration of healing of the 154 cases was as follows: 21 less than one year, 47 one to two years, 19 two to three years, 18 three to four years, 3 four to five years, 20 five to six years, 4 six to seven years, and 3 seven years or more. 16 recurred, of these 1 died of another disease during

treatment, 2 healed under further treatment, 3 discontinued treatment, 3 were advised to have operation, 1 delayed coming for treatment until it was too late for radium to be of service. Three deaths occurred prior to January 1, 1911, from some other disease. In 3 of the 154 cases it was necessary to resort to operation following the radium treatment; on the other hand, there were 15 cases in which operation failed and radium was afterwards employed successfully, and several of these had had more than one operation.

The cases in this series do not show the best results that could have been obtained by radium if only those most adapted to its use had been chosen. These results could not be compared with the results after operation, as no tabulated statement of consecutive cases could be found showing what measure of permanency had been obtained by this means.

Unless one has watched such a series of epitheliomas as I have described, and seen so many of them heal and in many cases leave so slight a scar that the site of the disease is not easily recognized, it is difficult to believe that such benign results can follow the use of a remedy that can be neither seen nor felt.

Treatment by radium should be begun early and nature must do her share. Improvement, indicating

that the treatment is likely to be successful, usually takes place within two or three weeks, and sometimes within a shorter period; or a new growth may heal after only two or three applications. This initial improvement may consist simply in the arrest of the growth and in signs of drying up, or in a freer discharge. On the other hand, radium treatment may at first make the diseased area look worse. For example, a patient had on the side of the nose a wart which had been torn off. Irritation and ulceration followed. The application of radium caused an increase in the redness, swelling and discharge, but after a few exposures the discharge and swelling subsided, the induration disappeared, and the ulcer healed rapidly. It seemed as if the indurated base had to be got rid of before healing could take place. If there has been discomfort or pain, it is usually relieved by radium, sometimes within an hour or two; this is probably due to the analgesic action of the gamma rays. (See page 34.)

In new growths where there is open ulceration and considerable induration, radium causes rather free discharge and the induration seems to melt away. The pain that sometimes accompanies this process is due, I think, to small collections of fluid and seems to be caused by pressure, as it is relieved after free discharge.

Rapidly growing and discharging new growths

respond to radium more readily than do those of an indolent type; if one of the latter type is healing very slowly, another form of treatment may well be considered, but if there is a question of cosmetic results, or of recurrence after an operation, it may be wiser to persist with radium.

Radium will bring about healing in some growths that are extensive and even inoperable, but, while they show its power and efficiency, every endeavor should be made to have radium used sufficiently early to prevent the occurrence of these larger growths. In the treatment of early skin cancers radium finds a great opportunity. It is important that physicians and surgeons should realize the value of this remedy.

If radium as an initial remedy, in sufficient quantity and properly employed, does not bring about marked improvement within three or four weeks, it would, as a rule, be better to choose some other method; this is rarely necessary if the case is at all suitable for radium treatment. If, however, radium should prove unsuccessful, the slight delay thus caused is not detrimental to the patient.

In treating old and feeble patients, or those having poor circulation, radium must be used cautiously in order to do good only; in such patients healing may be slow, or they may have so little vitality that they do not respond, so that after the

radium has done its work of destroying the diseased tissues, healing does not take place. If a patient is otherwise diseased, radium is handicapped. In cases which do not yield to radium it is well to bear in mind that the disease may be of syphilitic origin and to try specific treatment.

Sometimes it is feared that treating a cancer in one place may cause its appearance elsewhere, but so far as I have observed, this has not happened in any of the patients suitable for radium treatment.

It is interesting to note that surgeons and their relatives have come for this painless treatment rather than submit to operation.

Glands, Tongue, Mouth or Tonsils. In new growths of the glands, tongue, mouth or tonsils, no time should be lost by using radium from the outside; for this purpose and in this way it is unsuitable. To be of service the treatment must be begun in a very early stage, and as patients are not aware of the seriousness of the disease, they delay seeking advice until the growth has become too extensive to be materially benefited by radium.

Radium After Other Forms of Treatment. Radium is more successful when it is the first treatment employed than when used after operation, caustic, or other irritating forms of treatment, or the Roentgen rays, but even under these circum-

stances the results have been satisfactory, although a longer time is usually required to cause a disappearance of the new growth than when it is the primary remedy. In some cases success has followed the use of radium where treatment by the Roentgen rays had failed.

Radium in Recurrences. Those who have been operated upon for cancer, even of the breast, should be seen at stated intervals and if there is any sign of recurrence, such as spots of induration in or near the scar, they should be treated with radium, which in some cases has been found to be more efficient than any other treatment in checking a recurrence of this character. There may be recurrences after any method of treatment, but I believe they occur less frequently after radium than after operation. Such recurrences, as a rule, yield to further treatment by radium. Patients should be required to report after six months for observation.

Radium Treatment of Epitheliomas Resulting from Roentgen Ray Burns. In epitheliomas resulting from Roentgen ray burns, radium has been used successfully. At first thought, the treatment by certain radiations of a condition caused by similar radiations might appear to be an unusual procedure; nature, however, does not discriminate

between new growths whether proceeding from Roentgen ray burns or from some other cause.

The Gamma Rays as an Analgesic. The gamma rays have a value in some painful affections, for example, in certain forms of facial neuralgia. When using them, in order to avoid a burn, care must be taken to exclude the electrons, since the proportion of the gamma rays is so much smaller than that of the electrons that the exposure must be much longer when the gamma rays alone are used. Burns have been reported from France when patients were treated for neuralgia without excluding the electrons.

PART II
DISEASES OF THE EYES
AND EYELIDS

CHAPTER I

DISEASES OF THE EYES

Sir J. Mackenzie Davidson had a very clear perception of the potential value of radium in diseases of the eye. In his address as President of the Section of Radiology at the meeting of the British Medical Association in July, 1910, he made the following statement:

“But if radium has not so far fulfilled all the hopes that were entertained of it, it has, at any rate, accomplished something, and it is encouraging to turn for a moment to a new field of experiment in which it has yielded good and definite results—namely, certain diseases of the eye. Here, again, the diseases in which it is potent are ‘superficial.’ So far as we have tried it in deep-seated diseases, the results are negative. On the other hand, in some external diseases of the eyes and eyelids, its action is very remarkable, and I feel sure that radium will take a high place in ophthalmic therapeutics. By way of example, I may instance five cases of spring catarrh which I have cured by radium. The first of these was cured four years ago, and there has been no recurrence. Some of these cases were extremely severe, and one of

them, of over six years' standing had undergone a great variety of treatment, both operative and otherwise, without any permanent benefit. And besides these, in cases of episcleritis, hypopyon ulcers (corneal ulcers generally), incipient keratitis, and even in bad cases of pterygium, extraordinarily good results have been obtained."

Fortunately, most diseases of the eyes are near the surface, and all are within reach of the electrons, which have most value as remedial agents. The radium should be in a suitable container, with such filters as will permit the use of the radiations applicable to a given condition, the container being held so that the radiations will reach the part it is desired to treat, and near but not touching the eye, for the required length of treatment. In treating the lens and the anterior portions of the eye, the radiations should be directed from the front to the back; in treating the retina, the eye should be turned to the right or left, or up or down, the radium being so held that as much as possible of the radiations will reach the posterior portions of the eye.

The practitioner should realize that in treating the cornea or the lens, the effect of the radium continues for a considerable time, it may be for a month or more, hence the intervals between the treatments should be at least four weeks.

It sometimes happens that patients notice improvement in vision within a few minutes after treatment. This may be due to fluorescence in the cornea caused by the radium.*

The field of radium in diseases of the eyes is not as yet completely developed, but the number of such cases treated by radium is sufficient to show that it can be of value in the majority of diseases of the eye, excluding, of course, errors of refraction and affections of muscles and nerves. It may be stated with confidence that radium can be of more service in more diseases of the eyes than any single remedy hitherto at our disposal.

So far as possible, in all cases, tests of vision before and after radium treatment have also been made by the oculists who referred the patients to me.

*While measuring the absorption of the radiations from radium in the cornea of a pig's eye, I found that the cornea was made fluorescent; it is probable that radium would have the same effect upon the cornea of the human eye.

CHAPTER II

INSTRUMENTS

Instruments for use in diseases of the eyes should be designed in a way to protect the other parts while treating the diseased area.* (See Fig. 1.) To this end the diaphragms are made of coin gold, and pure gold is used for the container, as a tighter joint can be made between the cover and the container with the softer metal. The thickness of gold used as a protection, 5 mms., is more than fifteen times the thickness required to absorb all of the electrons.

The salt (26 mgs. radium element) is in a thin layer, 5 mms. in diameter, and completely fills the cell, so that by using diaphragms of varying diameters, we may exclude the radiations except those which come through the opening in the diaphragm; this also gives an opportunity to employ different amounts of radium element from the same container; for example, with this container a 4 mm. diaphragm would give 17 mgs., and a 3 mm. diaphragm 9 mgs. of radium element. When

*All of the instruments used in treating the eyes were made for me with exceptional skill by Mr. Arthur P. Woodbury, Beverly, Massachusetts.

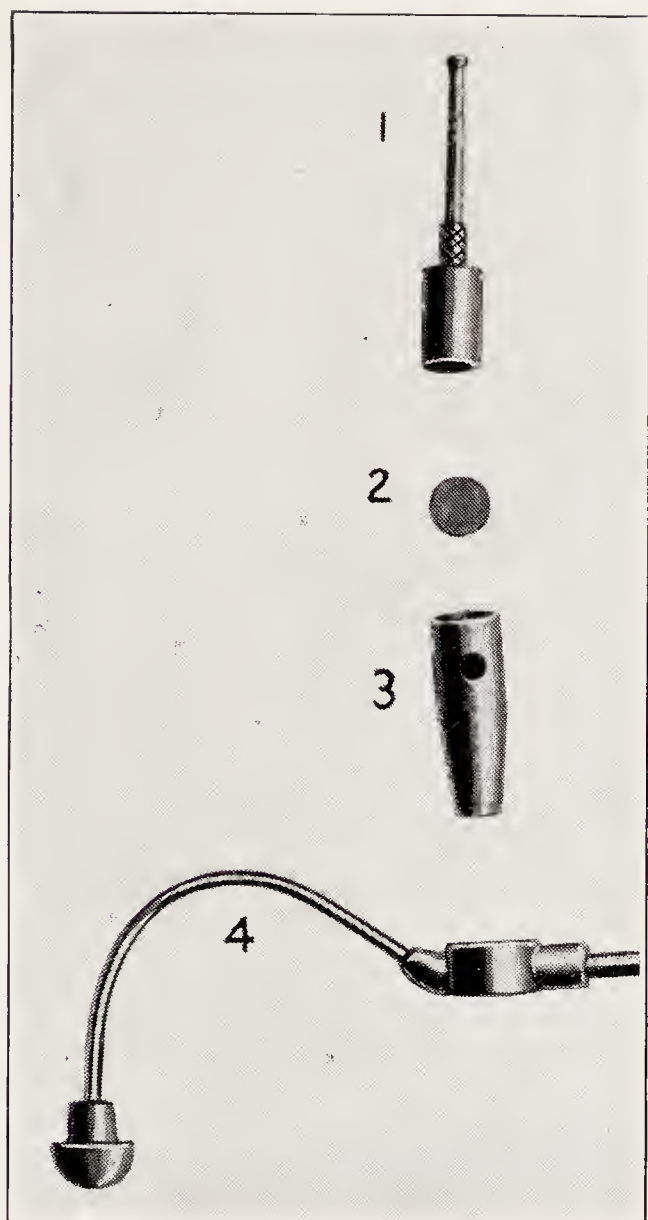
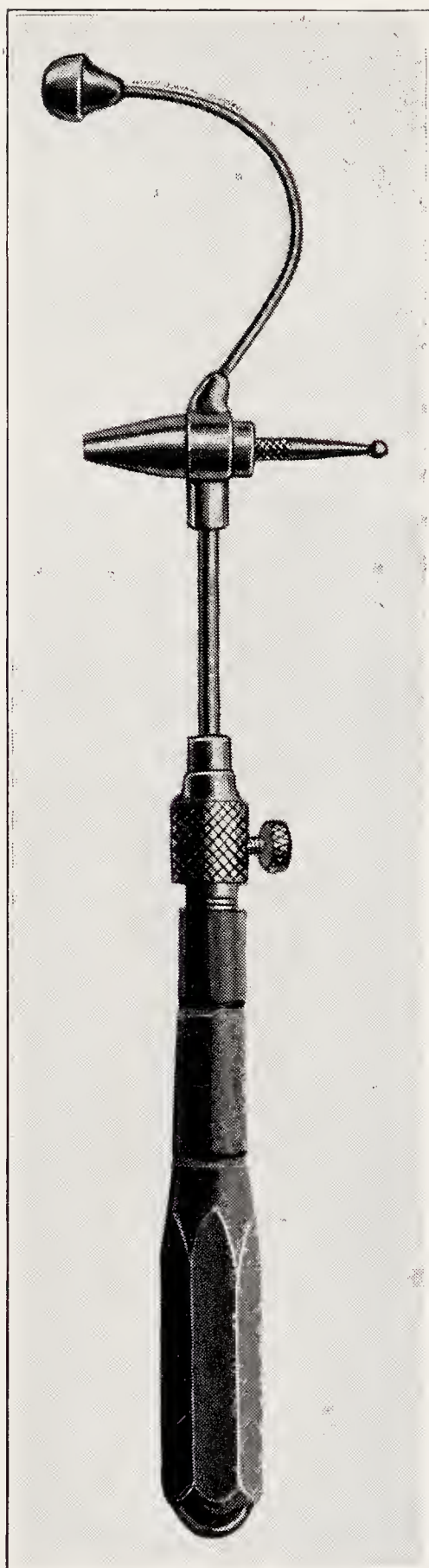


FIG. 1. Eye Instrument. Two-thirds size. To assemble the instrument, take No. 4, place into it the diaphragm, No. 3, with the opening in its side opposite the rod of the holder; drop the filter, No. 2, into No. 3, then put the container, No. 1, which has the radium in its lower end and the pointer screwed into its upper end, into the diaphragm; then screw the rod, which forms the handle of the instrument, through the opening in the upper part of the diaphragm and against the side of the container; thus all these parts are held firmly together. The knob at the end of the curved rod rests upon the forehead.



not in use, the radium container is inserted into a cylinder of gold and held in place by a wire spring.

There may be some secondary radiations arising from the walls of the diaphragm which, however, would be absorbed by the piece of sheet rubber which is stretched over the diaphragm and container and held in place by the pointer.

Lid Retractors. For the lower lid, a piece of $\frac{1}{2}$ -inch adhesive plaster 25 cms. (10 inches) long is folded nearly in the middle, leaving exposed about 13 mms. ($\frac{1}{2}$ -inch) of adhesive surface. On the lower (folded) end is fastened a small weight, for example a clamp weighing 4 grammes. The upper end of the plaster is stuck on the lower lid near its edge and the weight carries the lid down without discomfort.

For the upper lid, a piece of rattan 30 cms. (12 inches) long and 3 mms. ($\frac{1}{8}$ -inch) in diameter, is wound at one end with 1-inch adhesive plaster until its diameter is about doubled. Then a piece of plaster long enough to go one and one-half times around is put on with the adhesive surface exposed; then another not quite all the way around, but leaving exposed an adhesive surface about 3 mms. ($\frac{1}{8}$ -inch) wide. This, when put across the middle of the upper lid and rotated upward, carries the lid comfortably out of the way. (See Fig 2.)

Quartz Lamp. An excellent illumination for examining the eyes is afforded by a straight electric dental lamp, covered with a piece of red rubber tubing about 4 cms. ($1\frac{1}{2}$ inches) long, of which 15 mms. ($\frac{5}{8}$ -inch) extends over the end of the lamp and just covers a piece of quartz rod of the same diameter, 7 mms. ($\frac{1}{4}$ -inch), as the inside of the tubing and about 13 mms. ($\frac{1}{2}$ -inch) long, which is inserted into it. With this lamp a strong light, the intensity of which may be controlled by a special rheostat, can be directed into the eye at various angles.

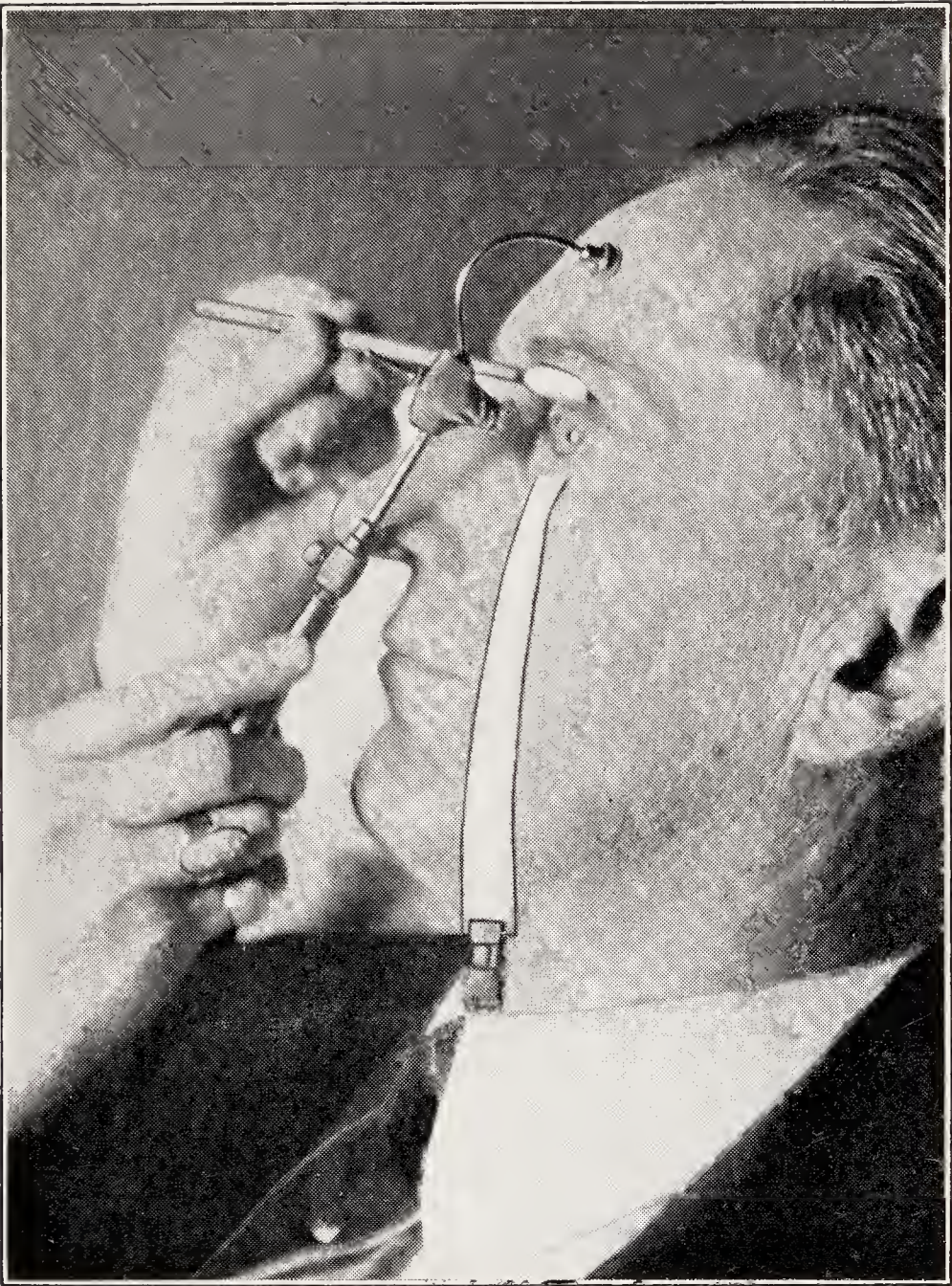


FIG. 2. This cut shows the method of applying the radium. The lower lid is held open by attaching to it a strip of plaster with a clamp, weighing 4 grammes, at its lower end. The instrument with the adhesive surface is placed upon the upper lid and rotated, thus lifting the lid, and separating the lids without discomfort to the patient. The instrument carrying the radium is held with the knob resting on the forehead. The patient is sitting in a Morris chair.

CHAPTER III

METHOD OF TREATMENT

Measurements. The method used in the treatment of diseases of the eyes is based upon measurements which show the proportion of the electrons that are absorbed by or pass through the cornea, the aqueous, and the lens; that the remaining electrons go no farther than about the middle of the vitreous; and that the filter covering the radium should be thinner or thicker according to the site of the diseased area. The accompanying gamma rays, being small in amount, can be disregarded, since, in the comparatively short treatments necessary, they would have but little action.

Through these measurements, radiations which are effective in certain diseases of the eye, and which had not previously been within our reach, were made available. With the knowledge of the amount and quality of the different electrons to be used in the treatment of diseases of the eye, and the selection of those most applicable to the condition to be treated, radium may be used safely, and not only safely, but also with better results than can be attained without such guidance.

A patient with a growth in the conjunctiva illustrates the importance of selecting the particular radiations applicable to a given condition.

A woman, 62 years of age, with a lipoma in the conjunctiva, was referred to me by her oculist, who had removed part of the growth five months before. The growth was raised above the surface about 1 mm. and extended from the outer edge of the cornea inwards about 1 mm. and outwards over the sclera 4 to 5 mms. The blood vessels extending from the growth outward were dilated, forming a very dark fan-shaped network. There was improvement at first, shown especially by marked diminution in the congestion, then there seemed to be no further progress, and as I thought other radiations would be more successful, I had an instrument made containing 26 mgs. of radium element, with a cover of 0.08 mm. of mica, which made it possible to use radiations not available before, and the growth disappeared promptly and completely; after a lapse of four and one-half years no difference in the two eyes could be detected, and two and one-half years later there has been no recurrence. Seventeen treatments were given with a filter of 0.30 mm. aluminum, or a little more, the average time of treatment being 8 minutes; then six treatments with the 0.08 mm. mica, and 9 mgs. radium element with a 3 mm. diaphragm, the average time of treatment being 7 minutes, a smaller amount of radium than the average which was used for the seventeen treat-

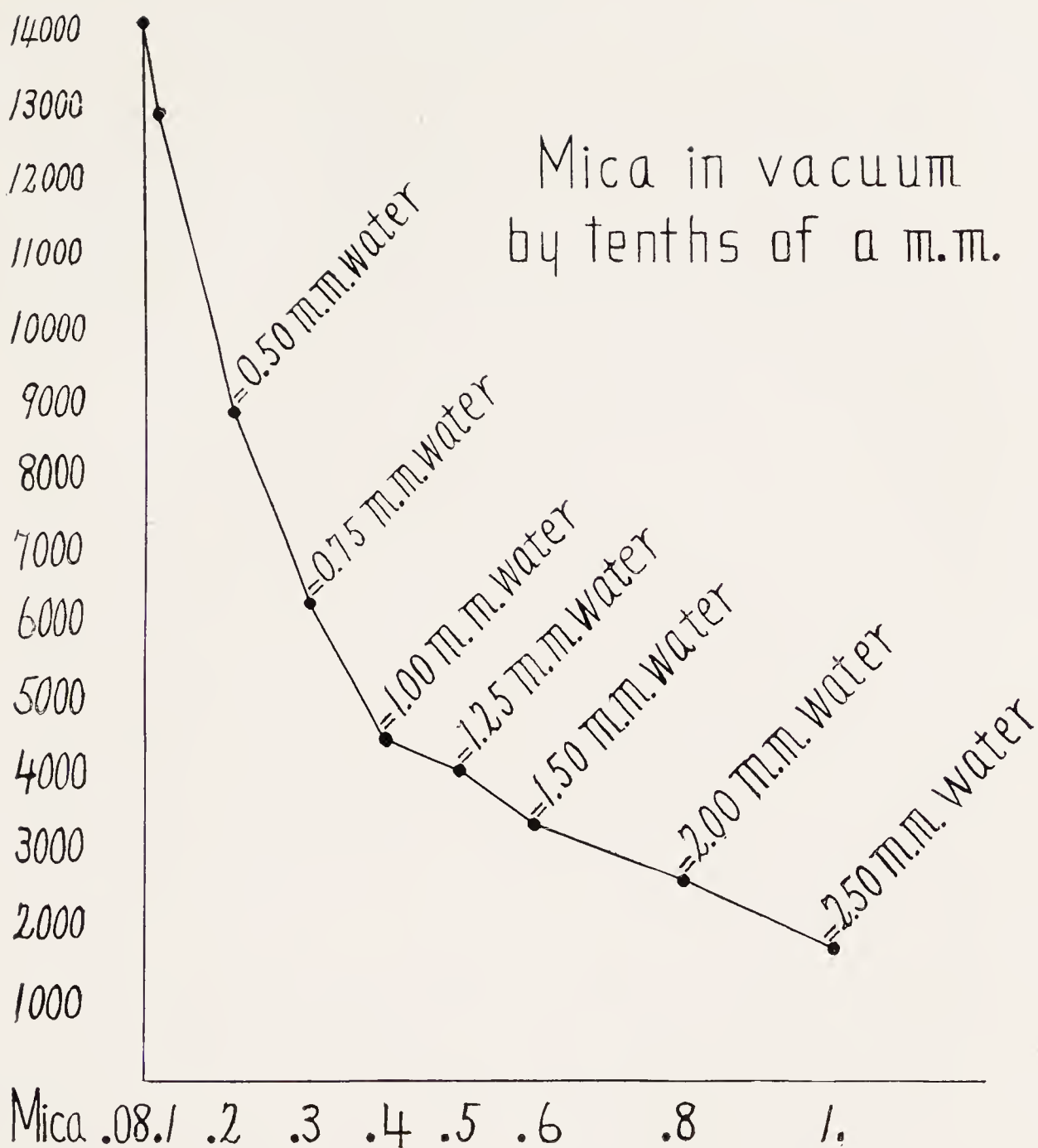


FIG. 3. This curve shows the proportion of the electrons absorbed by thicknesses of mica, in tenths of a millimetre, from 0.1 to 1 millimetre, and, by indicating the absorption by equivalent thicknesses of water, shows the proportion which would be absorbed in a given thickness of soft tissues, and therefore suggests how to choose the filters for obtaining the desired action. It will be noted that by the use of a very thin cover, the electrons of low penetrating power have been made available. Since mica and aluminum were found to correspond, this mica curve is used to determine the thickness of aluminum to be employed as a filter.

ments. Had these six treatments been used in the beginning, they would probably have sufficed. This illustrates that by choosing suitable radiations the desired end was attained. (See Fig. 3.) There was no irritation nor discomfort during or after treatment.

CHAPTER IV

DISEASES OF THE EYELIDS

New Growths. The results in 55 cases of new growths of the eyelids, beginning in 1904, have been most satisfactory. The diseased portion only is removed, and the disfigurement which may follow surgery is avoided; operation might leave the patient with a lid so small or so large as to harass him through life. In these cases radium treatment has now become the method of choice. In treating such cases, a bit of lead $\frac{1}{2}$ mm. thick may be placed under the lid to protect the eye from the radiations; by taking pains to have this lead plate a little larger than the area to be treated, made very smooth, with rounded corners, and curved to fit the eyeball approximately, with a double thickness of ZO adhesive plaster to form a handle for placing it gently under the lid and also for holding it in place, this has been done with but little discomfort to the patient.

A patient with melanotic sarcoma, whose eye had been removed about one month before, came to me for treatment of two small pigmented areas, which had been left by the operator to be removed

or treated later. These areas healed satisfactorily under radium treatment.

Radium is also of service in other diseases of the lids.

Ectropion. M. F. J., 69 years of age. Referred to me by Dr. P. Somers Smyth. Had ectropion, with complete eversion of the lower lid of the right eye, of one year's duration. The lid was thickened and indurated, and the patient had the usual distress accompanying this disease. After radium treatment the lid had lost its induration and had largely regained its normal position except that, from the stretching which it had undergone, it fitted the eyeball less closely than a normal lid. After the lapse of eleven months, time had remedied this to some extent, there remained only slight redness on the inner edge, and the patient had no discomfort.

CHAPTER V

OPACITIES OF THE CORNEA

The first successful radium treatment of opacity of the cornea, so far as I am aware, was a patient referred to me in 1904 by my brother, the late Dr. Charles H. Williams.

“The patient was a woman of middle age, who was suffering from a rather severe uveitis and an opacity of the cornea, which involved the lower and outer quadrant, and was so great that through portions of it the iris could not be distinguished. This opacity also included to some extent the central portion of the cornea. At this time the vision was less than 0.1. . . .

“The exposures were made at intervals of three to seven days, the lids being held apart and the radium placed first about $\frac{1}{2}$ cm. from the cornea, later about 1 cm., and still later 2 to 3 cms. Slight improvement was noticeable within two weeks, and at the end of ten weeks the improvement was marked; the inflammation had decreased throughout, the opacity of the whole cornea had diminished greatly, and the vision was 0.4. The patient at this writing has a vision of more than 0.5, and can read ordinary print.”⁹

In opacities of the cornea, radium is a most effective remedy. While the normal cornea is very resistant, the diseased cornea responds readily to these radiations.

Resistance of Cornea to Radiations. In order to test the resistance of the cornea to the action of the electrons, with the assistance of Professor Bernard E. Proctor of the Department of Biology at the Massachusetts Institute of Technology, I exposed one eye of several rabbits, leaving the other eye for control. 17 mgs. of radium element were used, with a filter of .08 mm. mica, through a tubular diaphragm 4 mms. in diameter and 5 mms. long, held at 4 mms. from the eye; far more of the radiations were absorbed in the cornea than are used clinically, and the longest exposure of the rabbit's eye was more than twenty times that used in treating the cornea. Exposures were made to one of the rabbits as follows:—

First exposure	15 minutes
Second, 39 days after first	35 minutes
Third, 108 days after first	1 hour
Fourth, 289 days after first	3 hours

All the rabbits were under frequent and careful oversight by Professor Proctor. The rabbit which had the longest treatment, as shown above, was examined through the kindness of Professor S. B. Wolbach, head of the pathological laboratory at

the Harvard Medical School, and under his direct supervision sections of the cornea of each eye were made, and no difference between the treated and the untreated eye was detected.

In treating the cornea, the cover of the radium should be thin enough to permit the passage of electrons of such low penetrating power that they would be absorbed in the cornea, and, as these rays are abundant, each treatment must be of short duration.

B. W. E., 62 years of age. Referred to me by Dr. Allen Greenwood. Central opacity in each eye, 2 to 3 mms. in diameter, the result of corneal ulcers in childhood. This patient is the widow of an oculist, had been persistent for years in her efforts to gain relief, and had had every advantage that ophthalmological skill could afford.

Before radium treatment she could see a church tower about 250 feet from my window, but was unable to see the clock on the tower. Four weeks after one treatment of 8 minutes with 17 mgs. radium element, through a 4 mm. diaphragm, and a filter of .08 mm. mica, when asked if she could see the clock, she replied instantly by giving the correct time, twenty minutes after three. After the second treatment, she went on a three months' trip through the Panama Canal to Southern California, during which her improvement held.

Five treatments were given, the first three with 17 mgs. radium element, through a 4 mm. dia-

+ .50 D.

The fourteenth of August was the day fixed upon for the sailing of the brig *Pilgrim*, on her voyage from Boston round Cape Horn, to the western coast of North America. As she was to get under way early in the afternoon I made my appearance on board at twelve o'clock in full sea-rig, and with my chest, containing an outfit for a two or three years voyage, which I had undertaken from a determination to cure, if possible, by an entire change of life, and by a long absence from books and study, a weakness of the eyes which had obliged me to give up my pursuits, and which no

+ .75 D.

medical aid seemed likely to cure. The change from the tight dress-coat, silk cap and kid gloves of an undergraduate at Cambridge, to the loose duck trousers, checked shirt and tarpaulin hat of a sailor, though somewhat of a transformation, was soon made, and I supposed that I should pass very well for a Jack tar. But it is impossible to deceive the practiced eye in these

+ 1. D.

matters; and while I supposed myself to be looking as salt as Neptune himself, I was, no doubt, known for a landsman by every one on board, as soon as I hove in sight. A sailor has a peculiar cut to his clothes, and a way of wearing them which a green hand can never get. The trousers, tight around the hips, and thence hanging long and loose

+ 1.25 D.

around the feet, a superabundance of checked shirt, a low-crowned, well-varnished black hat, worn on the back of the head, with half a fathom of black ribbon hanging over the left eye, and a peculiar tie to the silk neckerchief, with sundry other *details*, are signs the

+ 1.5 D.

want of which betray the beginner at once. Besides the points in my dress which were out of the way, doubtless my complexion and hands would distinguish me from the regular *salt*, who, with a sun-browned cheek, wide step

+ 1.75 D.

and rolling gait, swings his bronzed and toughened hands athwartships half open, as though just ready to grasp a rope. "With all my imperfections on my head," I joined the crew, and

+ 2. D.

we hauled out into the stream and came to anchor for the night. The next day we were employed in preparation for sea, reeving studding-sail gear, crossing royal

phragm, with a filter of .08 mm. mica, for 8, 7, and 6 minutes, respectively, to each eye. As the opacity was now smaller, the last two treatments were given with 9 mgs. radium element, through a 3 mm. diaphragm, with a filter of .08 mm. mica, for 7 minutes to each eye.

Before treatment, without glasses, with the right eye, she read at 12 inches, 1. D readily and most of .75 D haltingly. (See Fig 4.) After four treatments, with the right eye, without glasses, she read .50 D at 10 inches. The cornea of the left eye was perfectly clear. This improvement has already held for four years.

C. T., 61 years of age. Referred to me by Dr. Walter B. Lancaster. When the patient came to me he had opacity of the cornea in both eyes following ulcers, and was practically blind. The right eye was not treated because of disease in the deeper parts. The opacity in the left eye covered the whole of the cornea, and was comparatively thin around the edges but very dense in the central portion, so that the patient had only light perception but no useful vision. After the first treatment the opacity began to clear up at the edges, and after the three treatments the cornea was perfectly clear, and he could read fine print easily. This patient was shown at the meeting of the Association of American Physicians in May, 1925.¹⁶ (See Fig. 5.)

B. J., 18 years of age. Referred to me by Dr. Allen Greenwood. A college girl, whose eye had been torn open four years previously in California

when she fell into a rose bush having large thorns. The eye was saved, but a very large and most disfiguring corneal scar was left. This patient was obliged to leave Boston before the end of the treatment, but her disfigurement was greatly diminished, and marked improvement in vision followed each treatment.

A very striking instance of the prompt action of radium is shown in a patient, 67 years of age, who had a central opacity of the cornea, 3 mms. in diameter, and who could read only 1.50 D before treatment. Vision improved from this to .75 D as the result of one treatment of 4 minutes, with 17 mgs. radium element through a 4 mm. diaphragm, with a filter of .08 mm. of mica; that is, he could read all but the finest test type one month after this treatment.

In the earlier of the 17 cases of opacity of the cornea, the radiations which later seemed to me best for this purpose were not available; nevertheless, there was improvement in all cases but one, in which there were complications. Since suitable radiations have been used, the improvement has been striking and satisfactory; the superficial forms, however, improve more readily than the interstitial forms. In some cases the sight has been very greatly improved so that the patient had perfectly useful vision without, however, getting rid



FIG. 5. Opacity of the cornea after the left eye had had three treatments with radium. Before treatment he had opacity in each eye covering the entire cornea, and was practically blind. A few weeks after treatment he had good vision in the left eye and the cornea was perfectly clear. The opacity in the right eye was not treated, disease in the deeper portions making treatment unavailing.

of the last trace of the opacity. In other cases the cornea has become perfectly clear without any trace of opacity. In those cases in which the surface of the cornea was rough and faceted, it became smooth after radium treatment.

The cases reported above were due to ulcers; corneal opacities caused by burns, as in explosions, for example, have not responded to radium treatment.

CHAPTER VI

CATARACT

Usual Treatment. The usual treatment of cataract means waiting for a long time, it may be years, until the cataract has matured, during which time the vision is failing; then follows removal of the lens by operation, and not infrequently secondary operations. This leaves the patient without a lens, and therefore with no power of accommodation, the lens which has been removed being replaced, though imperfectly, by wearing glasses.

Radium Treatment. With radium treatment, the patient retains the lens with its power of accommodation, instead of being obliged to use a poor substitute. It is difficult for those who have not seen these results to believe that so much improvement in vision can be brought about simply by having certain radiations go into the eye, not only without pain or discomfort, but even without sensation.

Measurements. My first cataract patient was treated in May, 1923. Before treating cataracts I measured the amount of radiation, penetrating

filters of different thickness, which was absorbed in 1 mm. of water. Measurements were also made through 3 mms. of water, corresponding to the cornea and anterior chamber; and through 7 mms. of water, corresponding to the tissues between the front of the cornea and the back of the lens; the difference between these would represent approximately the amount absorbed by the lens. The amount absorbed by the fourth and the sixth millimetres of water corresponds to the anterior and posterior portions of the lens, respectively.

Anterior Capsular Cataract. Since the measurements show that more of the radiations are absorbed in the anterior than in the posterior portions of the lens, we should expect any opacity in the anterior portion to yield more promptly than in the deeper parts. This was confirmed in a very striking manner in a patient with anterior capsular cataract, where the results of the treatment could easily be followed. The whole of a very large pupillary area was filled with what had the appearance of a white, roughened, porcelain-like surface, which was so opaque to light that even when the patient was put in a position facing a glare of reflected sunlight, and asked if he could see anything, he said, speaking with hesitation, "No, but I think that there is light in that direction," pointing in front of him. After three treat-

ments, the opacity in the capsule had disappeared, leaving a grayish, translucent, mature cataract.

Filters. When the lens is to be treated, the filter should be thick enough to exclude the rays of low penetrating power, but yet thin enough to allow the passage of such rays as would be absorbed in the lens, and, as these rays are less abundant, the length of the individual treatment should be longer than that used in treating the cornea. Exception, however, must be made in some cases, as measurements show that of each millimetre of thickness of the lens, more is absorbed in the anterior than in the posterior portion, and tests with different filters show that thicker ones diminish the amount reaching the posterior portion of the lens. It may, therefore, be necessary or desirable to use for a time a very thin filter, yet one that would come within the limits of safety to the cornea.

G. A. E., 78 years of age. Near vision normal; distant vision defective. On the fourth day after the first treatment she could see figures on the wallpaper of her room, which she had thought was plain, and in three weeks could see that there were colours in the paper. In ten weeks after the second treatment she recognized the features of people who passed her house, which she had not been able to do previously. In sixteen weeks she

could see the sand dunes better, and a week later could tell the time on the town clock a block away. Six treatments were given, and after five years her improvement still held.

P. W. J., 68 years of age. Referred to me by Dr. Louisa Paine Tingley. Vision had been failing rather rapidly of late. Fourteen treatments were given with 17 mgs. radium element through a 4 mm. diaphragm and a filter of .08 mm. mica and .5 mm. aluminum, averaging 7 minutes to each eye. Before treatment Dr. Tingley's report of vision was as follows:—"With correction, V.O.D. 3/10 and No. 6 J; V.O.S. 3/10 and No. 6 J." Six months after the last treatment Dr. Tingley reported:—"Cataracts have absorbed in a measure—possible to get a picture of fundi with ophthalmoscope. Vision corrected, V.O.D. 9/10 and No. 4 J; V. O. S. 8/10 and No. 2 J. Reading looks smoky. There has been decided improvement in vision of this patient."

F. E. C., 81 years of age. Referred to me by Dr. L. Maud Carvill. Incipient cataract of right eye. Does not use reading glasses. He had six treatments of 10 minutes each, with 17 mgs. radium element, through a 4 mm. diaphragm with a filter of .08 mm. mica and .5 mm. aluminum. Before treatment, V.O.D. 1. D readily at 9 inches; .75 D with hesitation. Six months after the last treatment the test of vision was V.O.D. .50 D readily at 9 inches. The improvement held until his death two and one-half years later. This patient

illustrates the importance of early treatment before there is much impairment of vision.

M. H. F., 61 years of age. Cataracts in both eyes, of three years' duration. After three treatments of 20 minutes to each eye with 17 mgs. radium element through a 4 mm. diaphragm, with a filter of .08 mm. mica and .1 mm. aluminum, at intervals of one month, she reported as follows:—
“While sitting at my dressing-table I picked up my mirror, and I saw my face for the first time in two years. I could see my eyes and lines in my face which I had not known were there.” Five more treatments were given, then the patient was advised to discontinue treatment, as serious heart trouble and lameness from arthritis made the journey to Boston difficult.

H. E., 60 years of age. Referred to me by Dr. Elwood T. Easton. This patient had had failing vision, so that she had difficulty in doing her work. If the progress of the disease could be stopped, she could hold her position and would not lose the pension to which she would be entitled after three or four years. She had six treatments with 17 mgs. radium element, through a 4 mm. diaphragm, with a filter of .08 mm. mica, and .5 mm. aluminum, and an average of 9 minutes to each eye.

Before treatment, without glasses, with the right eye, she could read .75 D readily; part of .50 D haltingly. With the left eye, .75 D readily; .50 D somewhat slowly. After three treatments Dr. Easton found that she had gained one whole line. At the end of treatment, with the right eye,

she could read .50 D readily; with the left eye .50 D without the slightest hesitation. The left eye was now the better of the two. The crescent moon was clear cut, which it had not been for more than a year. She could see to thread a fine needle. This improvement held so that she was able to obtain her pension.

Economic Value of Radium Treatment. This patient illustrates the economic value of radium treatment to both the individual and the community. Many experienced and skilled workmen, and others having cataract, whose livelihood depends upon their vision, are disabled while waiting with failing vision for the cataract to mature for operation, and this may occur during the period of their greatest usefulness. Radium treatment may be begun before vision is seriously impaired, hence the disabilities attendant upon operation are avoided.

Diabetic Patients. The eyes of several patients who also had diabetes have improved. One of these was—

H. S. A., 65 years of age. Referred to me by Dr. T. B. Alexander. Cataracts in both eyes. Five treatments were given to the right eye and twelve to the left eye with 17 mgs. radium element through a 4 mm. diaphragm and a filter of .08 mm. mica and .1 mm. aluminum, averaging 20 minutes to each eye. Before treatment, with correction, V.O.D. 1.75 D; V.O.S. 1.75 D. At the

end of treatment, with correction, V.O.D. .50 D; V.O.S. 1 D. She could see to thread a needle at night, and could read numbers in the telephone book, which she had not done before. She died suddenly of heart disease two weeks after the last treatment. Later her sister-in-law wrote me, "It was wonderful to see her able to read in the evening after having been so nearly blind."

Three patients more than eighty years of age (81—84—87) responded satisfactorily.

Of the 40 cataract patients whom I have treated, 21 improved; 1 improved at first, but fell back after an interval without treatment; in 5 there were too many complications; 13 had too little treatment; of these 7 were the earliest patients, with whom it was necessary to proceed slowly in order to avoid doing harm, and the results were negative, 3 discontinued treatment, 3 had subsequent operation with good results.

All the cases of incipient cataract have improved, or have been able to read readily ordinary book type or even a much smaller type, and this improvement has held for years. It is gratifying to find that in these cases improvement is prompt. The general practitioner, who is often the first to see the patient, should bear in mind the possibility of cataract, and should realize the importance of beginning radium treatment in the incipient stage.

When the cataracts have progressed to a later stage, there is satisfactory improvement in some cases and only slight improvement in others; it would, therefore, seem best to try radium treatment, as there is at present no other way to distinguish between cases that might or might not be improved. Should improvement not follow, radium treatment does not prejudice operation.

CHAPTER VII

RETINITIS PIGMENTOSA*

P. E., aged 33 years. Had consulted four oculists, all of whom were agreed as to diagnosis, and also prognosis that nothing could be done for her and that she would be blind at forty. Later she went to another oculist, Dr. E. W. Clap, who wrote me as follows:—"Patient was seen September 17, 1924. V.O.D. 20/200; V.O.S. 10/200. She has a fine pigmentation of the fundus in the periphery with waxy nerves, perhaps congenital, but as vision has failed she was turned over to Dr. Williams to treat. Her field was contracted so that she could do very little and could not go about alone."

Of course, I could not promise that radium would help her, but I felt that I had no right to withhold anything which it might offer; I did promise, however, that the treatment would do no harm. After about one year (15 treatments) she came to my office alone and continued to come alone from another state, making five changes each way in transportation. After 33 treatments (two and one-half years) Dr. Clap wrote me as follows:—"V.O.D. 20/200; V.O.S. 4/30, but

*In 1904 I made the following statement: "The beta rays seem likely to prove a convenient and useful remedy in certain diseases of the eye, particularly those which have not yielded to other methods of treatment."⁹

field normal in extent. Slight improvement in direct vision, but great improvement in field, so that she was highly satisfied with the improvement."

During a period of three and one-half years she had 41 treatments with 17 mgs. radium element, through a 4 mm. diaphragm, with a filter of about 0.5 mm. aluminum, directed, without going through the lid, northeast, southwest, northwest and southeast, the eye being turned so as to expose the posterior portion, so far as possible, to the radiations, the average time of exposure being five minutes in each of these four directions. Then followed an interval of nine months without treatment, after which Dr. Clap wrote me as follows:—"Vision, fields and fundus seem exactly the same as last time. Whether treatment has delayed or stopped the degeneration in the chorioid I don't know, but I should have expected her to be worse by this time."

She was referred back to Dr. Clap to be under his observation and to return to me for further treatment should there be any unfavourable change. She is now forty-four years old and still holds her improvement.

It should be stated that in the diseases of the eye in which radium has been found to be of service, experience has shown that it can now be used in a way to bring about more prompt and satisfactory improvement than heretofore.

Not only may radium be of service directly in diseases of the eye, but indirectly as a preventive measure. It is recognized that in some diseases of the eyes infection may come from the tonsils. In such cases radium treatment of the tonsils may be followed by marked improvement in the eyes.

PART III
TONSILS AND OTHER
LYMPHOID TISSUE
IN THE THROAT

CHAPTER I

INFECTED LYMPHOID TISSUE IN THE THROAT

This subject is of importance to a large number of patients, to the surgeon and the laryngologist, and also to the general practitioner who is the first to see many of the patients who are operated upon each year in this country for the removal of the tonsils.*

The Tonsils as a Source of Infection. It is in the lymphoid tissue, not only in the tonsils but also in other parts of the throat, that various bacteria find their culture medium and, under the conditions of warmth and moisture present there, can flourish, giving rise to colds, attacks of tonsillitis, and arthritis. The poisons which these organisms produce can be carried to the heart, the eyes, and other organs, and do great harm. There is no

*Tonsillectomies done in one year in 24 of the hospitals in Boston and seven adjoining cities, population 1,180,000, were 13,325; operations done in other hospitals and in private practice would increase this number. On the basis of these figures, the tonsillectomies done in one year in the cities of the United States of more than 10,000 inhabitants, population 46,750,000, would be 514,240, more or less. The towns of 10,000 inhabitants or less, population 70,000,000, are not taken into account. Surgeons in this city tell me that more tonsillectomies are done in private practice than in hospitals; this would make the number given above at least 1,000,000 instead of 500,000.

The figures relating to population were obtained through the kindness of Professor Davis R. Dewey.

other small part of the body which is the starting-point of so much disability and serious disease, and now so amenable to treatment, as is the lymphoid tissue in the throat. It is necessary to get rid of this tissue when diseased, as it affects the well-being or may even endanger the life of the individual.

The following extract from "Allbutt's System of Medicine" (4: 770, 1900) is noteworthy:—"It is obvious that the tonsils play a very much more important part in admitting the various infecting microbes than has hitherto been conceded; and we have no doubt that their condition merits close attention when the question of the etiology of infectious diseases is discussed."

With early treatment of infected lymphoid tissue in the throat there should be fewer cases of infectious diseases. In scarlet fever the early use of radium may be helpful, and the throats of those who have been exposed to this disease, for example, children in the same family, when found to be infected, should be treated with radium as a precautionary measure.

Results of Radium Treatment not Due to Bactericidal Action. Judging by the tests made for me by the late Dr. F. H. Slack, when director of the Sias Laboratories, Brookline, Massachusetts, the

results obtained by the use of radium when short exposures are made are not due to a bactericidal action. In these tests the cultures were exposed for twenty minutes to 38 milligrams of radium element with a filter of aluminum 0.29 millimeter thick, at a distance of 0.25 centimeter. Dr. Slack reported as follows:—"I exposed freshly planted cultures of *Staphylococcus pyogenes aureus* and of *Streptococcus viridans* to the action of your radium for twenty minutes each. It had no inhibitive action at all upon the growth of these bacteria, the exposed cultures and the controls growing equally well."

Prevalence of Infected Tonsils. This condition is present in a considerable proportion of the population of this and other countries.

Examinations by the Life Extension Institute of over 100,000 adult males in the prime of life revealed enlarged, cryptic or buried tonsils in 45 per cent. Among school and preschool children examined in six different surveys, in four of the groups surveyed, one-third had enlarged or diseased tonsils. A recent study has shown that children who have, or have had, diseased or enlarged tonsils suffer much more frequently from rheumatism, lumbago, neuralgia, neuritis, heart diseases and ear diseases than those with normal tonsils.

Special estimates have placed the number of school children in the United States wholly or partially deaf at 3,000,000.¹ It is recognized that many of the diseases of the ear come from the throat through the Eustachian tube. In New York State in 1923-24 among 600,000 school children, 16 per cent had diseased or hypertrophied tonsils.⁵

School Children and Industries. Data indicate that the 24,000,000 school children in the United States lose 170,000,000 days per school year and the 36,000,000 wage earners lose at least 250,000,000 work days per year. These figures take into account only one-half of the total population.¹ The Metropolitan Life Insurance Company has found that "colds take more dollars and cents out of the worker's pocket than any other sickness. They are responsible for a greater loss of time from school and work than any other single cause." As a rule, after the first treatment of the tonsils by radium, patients cease to have their customary colds.

Heart Disease and Rheumatic Fever. Out of 44,000 pupils in the schools on the lower east side of New York, the principals and teachers referred to physicians 946 having or suspected of having cardiac defects. Of this number 403, or 42.5 per cent, were found to have cardiac trouble. Of 125

children segregated because of heart disease, whose parents were questioned carefully in regard to infectious diseases, tonsillitis had occurred in 82, or 64 per cent, rheumatism in 57, or 45 per cent, and scarlet fever in 16, or 12 per cent.³ "The onset of rheumatic heart disease occurs in 60 per cent of the cases before the age of twenty years and in 95 per cent before the age of forty."²

While infected lymphoid tissue in the throat is not a disease which figures in the mortality list, it is responsible directly for disability on a large scale, and indirectly for a certain percentage of deaths.

Because of the diseases which may have their source in the throat, for example, cardiac disease after rheumatic fever, it is important to have the treatment early. Acute tonsillitis is no bar to immediate radium treatment, since where this is also present, the attack is shortened, and prompt and striking improvement in both the throat and the rheumatic condition follows the treatment. Radium treatment of the lymphoid tissue in the throat should afford a way of diminishing eventually the amount of cardiac disease.

In families, or other closely associated groups, where there are cases of rheumatic fever, the throats of other members of these groups should

be carefully watched with a view to treatment, and I believe that the throats of all hospital patients should be carefully examined as a matter of routine, and that such examinations would be more than justified by the number of persons whose need for treatment might otherwise be overlooked.

CHAPTER II

OTHER FORMS OF TREATMENT

Tonsillectomy. For many years we have depended upon surgery for removal of the tonsils. Tonsillectomy is done more frequently than any other operation. It may be a serious operation, it does not reach the infected lymphoid tissue in other parts of the throat, and in many cases fails to remove all the tonsillar tissue.*

In marked contrast to this, we now have radium treatment. Infected tonsillar tissue is more susceptible to radium radiations than the adjacent normal tissue. The treatment is painless, can be used without danger, without interruption of the patient's occupation or change in diet, and seldom requires supplementary treatment. For singers and speakers† it is preferable to operation. It is useful in cases where tonsillectomy is incomplete, instead of a second operation. It can remove infected tissue in other parts of the throat which

*“... Tonsillectomy as usually done, even by specialists of established reputation, fails to accomplish this end in 73 per cent of cases because of incomplete removal of infected tonsillar tissue.”⁴

†This is illustrated by the case of an auctioneer who during radium treatment was able to continue the strenuous use of his voice that his occupation demanded, for three hours a day, and on one occasion almost at the end of treatment used it for three and three-quarters hours, a longer time than ever before, and felt that at the end of the day's work his voice was in fully as good condition as at the beginning.

can not be reached by operation. By this method the offending tissue only is removed, without harm to the contiguous tissue, and with far better results than by operation.

COMPARISON BETWEEN TREATMENT OF THE TONSILS
WITH RADIUM AND TONSILLECTOMY

<i>Tonsillectomy</i>	<i>Radium</i>
Anesthetic	Anesthesia avoided
One or more operations	A few painless treatments
Infected tissue in other parts of throat untreated	Other infected tissue may be treated
Shock	No shock
May remove other tissues than the tonsil	Removes only tissue it is desired to be rid of
Hemorrhage	No hemorrhage
Infection	No infection
Great soreness in throat	Avoided
Occupation interrupted	Occupation uninterrupted; an economic saving
Postoperative hemorrhage	No hemorrhage
Lung complications	No lung complications
Ear infection	No ear infection
May take a week or more for adults to recover fully from operation	Improvement in general condition sometimes begins within a day or two, and it continues
Operation inadvisable because of condition of patient	Can be used for patients who are not good operative risks
Many of the above, of course, seldom occur; in rare instances death may result	No deaths
Recurrences frequent	Recurrences infrequent

Comparison of Roentgen Rays and Radium in the Treatment of Tonsils. The use of the Roentgen rays in treating the tonsils is open to the criticism of exposing to the action of the rays other parts than those it is desired to reach. When the Roentgen rays are used, treating the tonsils from under the angle of the jaw, the maximum amount reaches other tissues than the tonsils, since the radiations are absorbed to a large extent by the intervening tissues where they are not desired, the parotid gland being particularly susceptible to them. When radium is employed inside the throat, the maximum radiation reaches the tonsils, and the minimum other parts. Good drainage is favored by this method, as the action of the electrons is stronger near the surface. Another advantage of radium is that the output is constant and the dosage can be exact.

CHAPTER III

PRECAUTIONS

Measurements. Measurements which I have made of the output from radium, to determine the proportion of radiations—

First, that would reach the tonsils through different thicknesses of aluminum,

Second, that escape through the back of the container and would reach other parts of the throat than the tonsils,

Third, that are absorbed by different thicknesses of tonsillar tissue,

Fourth, that are absorbed by the tonsillar tissue and the ramus of the jawbone,

make it possible to choose the radiations which should be used for treating the tonsils, and those which should be used for the lymphoid tissue in other parts of the throat, while excluding those which might be injurious. These measurements showed that of the total amount of the radiations going in any other direction than the tonsil, the proportion escaping from the container was only about 4 per cent., an amount that may be disregarded; of the radiations issuing from the front of the con-

tainer, with a filter of aluminum 0.29 mm. thick, the proportion absorbed by 13 millimeters of tonsillar tissue was a little less than 90 per cent., and the proportion absorbed by this thickness of tissue and the ramus of the jawbone was more than 90 per cent.

Limitation of Radiations. Naturally, the first thought of many practitioners would be that it is a serious matter to put radium into the throat; to do this without carefully limiting the radiations would justify the apprehensions that were generously expressed to me by some of my colleagues when I first began to use radium for the treatment of the tonsils, but these measurements show that the risk of injury to any part of the throat is negligible if proper precautions are taken. Among remedies of great power, I do not recall any in which the action is exerted so completely where it is needed, and at the same time, to so slight a degree where it is not desired, as is the case with radium, under the conditions to be described.

Adaptability and Safety of the Method. The physician should be well informed about radium before venturing to apply it, otherwise he may do harm to some patients or fail to do the good that should be accomplished. Training and experience are required to determine the conditions under which it should be employed for treating the ton-

sils and the amount and quality of the radiations which should be used. Since the conditions in the tonsils vary greatly, it is desirable that a method be used which is adaptable as to both the amount and the quality of the treatment. The method that I have employed, carried out with instruments devised by me for using radium in the throat, has proved to be safe and effective.

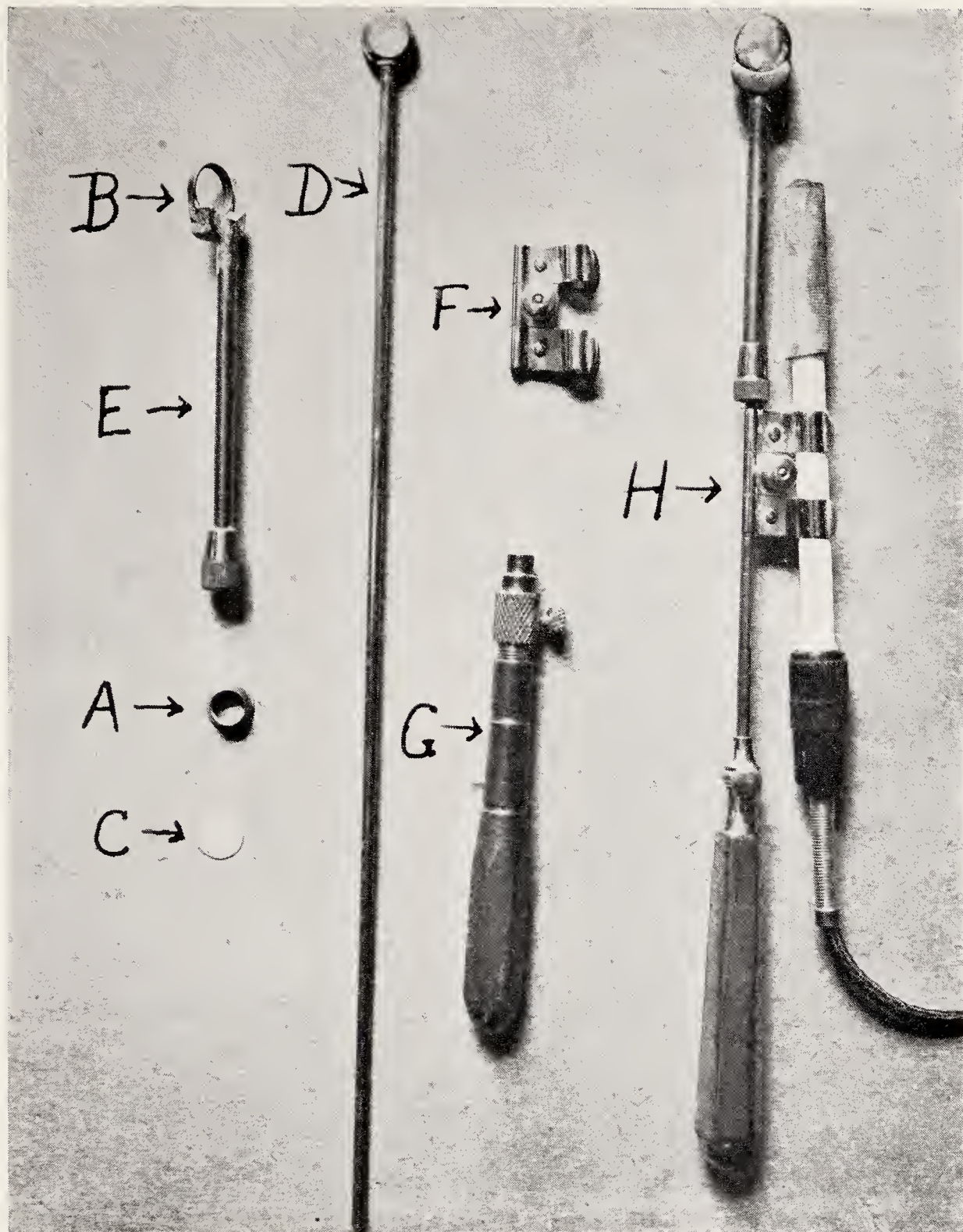


FIG. 6. The separate portions of this instrument, except the lamp, are shown on the left of the cut. To assemble the instrument, the circular diaphragm A (9 mms. in diameter and 5 mms. deep) is put into the ring B and into this is dropped the filter C. (See also Fig. 10.) Then the Monel metal rod D, bearing the container, is slid through the tube E until the radium is brought directly above the filter and the diaphragm, and by turning the milled head at its lower end the tube E is clamped to the rod D. The spring clamp F is slid over the rod and secured by means of a nut on its side, and the rod is slid into the handle G and fastened by a setscrew. Then the lamp is pressed into the spring clamp F. Assembled instrument H. When the container is not in use a disk of gold 5 mms. thick is dropped into the diaphragm holder B, from which A has been removed, and the rod D is slid into the tube E until the container is in place above the disk.

CHAPTER IV

INSTRUMENTS

Container. The container, a disk of pure gold in which the radium lies in a thin, uniform layer, is on the end of a Monel metal rod about 3 mms. ($\frac{3}{32}$ inch) in diameter and about 30 cms. (12 inches) long. (See Fig. 6.)

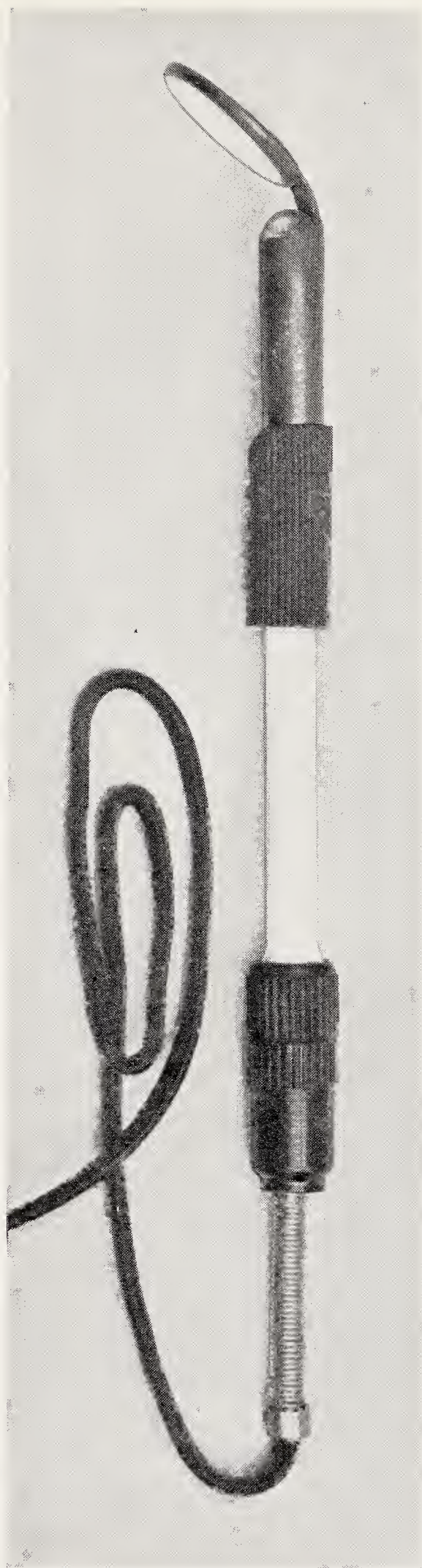
To make this container, a disk of pure gold 14 mms. ($\frac{9}{16}$ inch) in diameter and 7 mms. ($\frac{1}{4}$ inch) thick is turned out on one face to a depth of 2 mms. ($\frac{1}{16}$ inch) leaving a rim 1 mm. thick and 2 mms. high. Then the central portion of the depression is deepened 0.5 mm. and widened to a diameter of 9 mms. ($\frac{3}{8}$ inch), making a space just sufficient to hold 55 mgs. of radium element in the form of sulphate. This is covered by a disk of mica 0.03 mm. thick, to protect from the action of the radium the disk of aluminum 0.29 mm. thick, placed above the mica. Over this a hollow steel cone is pressed down upon the gold rim, of such shape that the rim is squeezed inwards and over the edge of the aluminum. After the removal of the cone, by means of further pressure on a flat plate of steel placed above the gold rim, this

is forced firmly against the aluminum and thus a strong tight joint is made. While the pressure is exerted upon the gold container, it must be held in a piece of steel, which fits it exactly, otherwise the container will be put out of shape by the strong pressure upon it.

Lamp. A straight electric dental lamp, which gives a strong light, is held between double spring clamps and, by turning a round nut, is fastened to the metal rod by another clamp. (See Fig. 6.) The upper part of the lamp is covered with a piece of sterilized red rubber tubing (black is too translucent), a fresh one for every patient, that shuts out all the light except at this end. At the lower end of this lamp are attached a hard rubber socket and a wire for the electric current. The current may be turned off from the lamp by giving the hard rubber socket a half turn to the left. Since the lamp and the container move together, the container and the portion of the throat to be treated receive a good illumination, the intensity of which may be varied by adjusting the special rheostat which controls the lamp. A sterilized lamp, one of a number sterilized, is always ready for use.

Laryngeal Mirror. A laryngeal mirror (Fig. 7) is useful for examining lingual tonsils and the

FIG. 7. Laryngeal Mirror. Opposite the lower portion is an electric lamp, covered for a short distance, except at the very end, with a pure silver tube split lengthwise, which is continuous with the broad band of pure silver attached to the back of the mirror. The red rubber tubing, pulled back in order to show the silver tube underneath, is cut off at one end at an angle of 45 degrees, in order to obstruct as little as possible the observer's complete view of the mirror. At the other end of the lamp is a socket and cord attachment.



larynx. The backing of the mirror is of pure silver and there is no paper between the silver and the mirror. Opposite its lower portion is an electric lamp, covered for a short distance, except at the very end, with a pure silver tube split lengthwise, which is continuous with a broad band of pure silver attached to the back of the mirror. It is necessary that pure, not sterling, silver be used, otherwise the conduction of heat from the lamp to the mirror would be insufficient. This mirror may first be warmed by holding it over a lamp, but after being put into the throat, the electric lamp attached to it keeps it warm enough to prevent the condensation of moisture on its surface from the patient's breath, but not so warm as to be uncomfortable. A piece of red rubber tubing, pulled back in order to show the silver tube underneath, is cut off at one end at an angle of 45 degrees, in order to obstruct as little as possible the observer's complete view of the mirror.

Tongue Depressor. Figure 8 shows a common form of tongue depressor with an electric lamp attached, the light from which is excluded except where it is desired. If a broader tongue depressor is needed the lamp may be taken off the rod, as shown in the cut, and put on the other rod.

Timing Exposures. For timing exposures a stop

watch, such as is used in football games, is convenient; while the treatment may be interrupted as often as is necessary—to allow the patient to swallow, for instance—the total length of the treatment may be accurately registered.

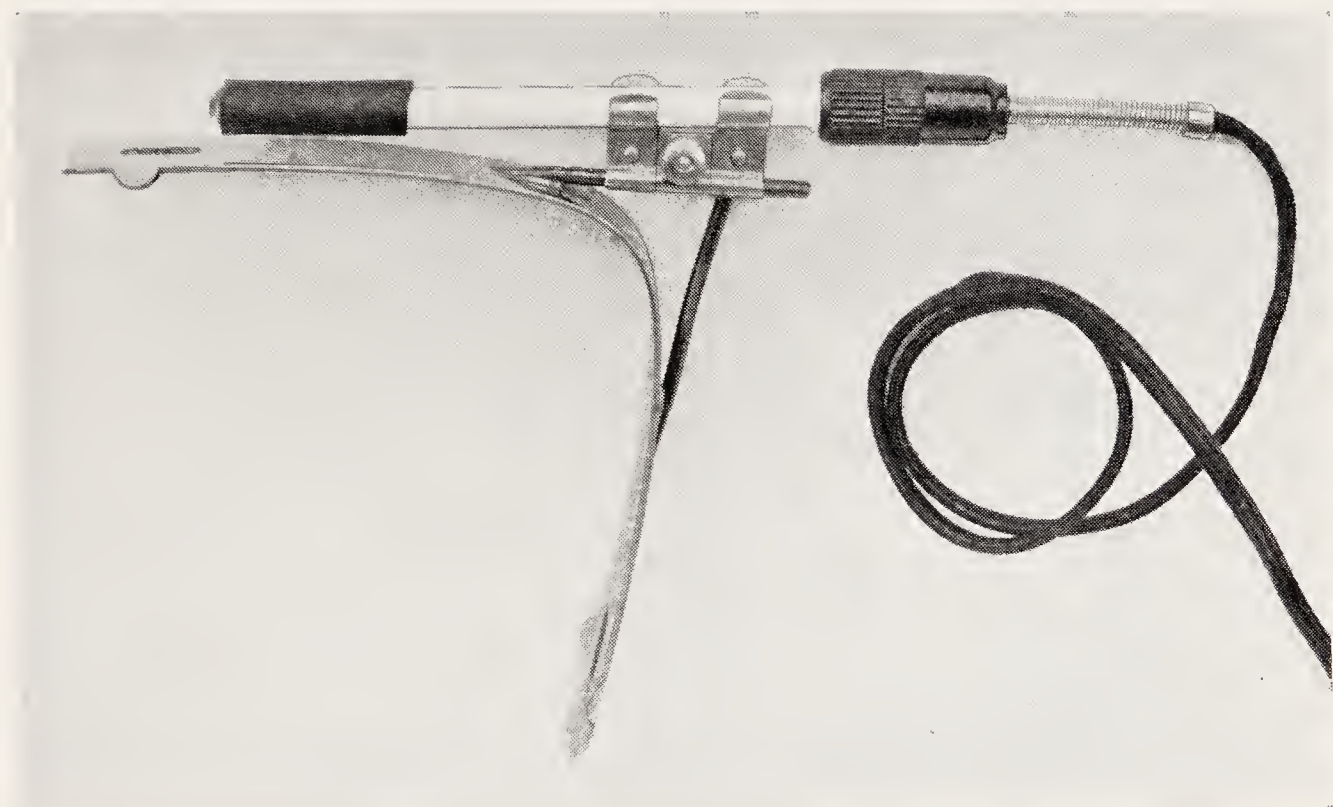


FIG. 8. A common form of tongue depressor, with attachment for holding the electric lamp.

CHAPTER V

TREATMENT

Method of Applying Radium. The application of radium is simple. (See Fig. 9.) The patient has only to keep his mouth open while the container, covered by a thin rubber cot (a new one for every treatment) kept in place by small rubber bands, is held gently against the tonsil, the amount of radiation and the quality of the electrons absorbed within the tonsil being controlled by a suitable filter, and their spreading limited by diaphragms of different sizes and shapes (see Fig. 10), the small proportion of the very penetrating gamma rays passing on and out. Since the electrons have different degrees of penetrating power, the less penetrating ones, being in larger proportion, must be shut off by a suitable filter when the deeper tissues are to be acted upon, otherwise the tissues near the surface will receive too much radiation.

Treatment. The application of radium is painless. The treatment may be so moderate as to produce no discomfort in the tonsils or so vigorous as to cause some irritation there for a few days. There may be reasons, especially from the patient's point of view, for choosing one or the other

of these methods. Four treatments of six to ten minutes to each tonsil, using a filter of aluminum 0.6 mm. thick, at intervals of about three weeks, are usually sufficient. In some cases fewer treatments, each of somewhat longer duration, may answer; in a few cases a single treatment has sufficed. In exceptional cases, however, a treatment of eleven or twelve minutes has been found desirable; the filter then should usually be 0.7 mm. thick. These applications, as a rule, cause no gagging nor real discomfort, but if the throat is unusually sensitive, a spray of a freshly made 2 per cent. solution of cocaine may be used; in the majority of cases this has been unnecessary.

If the same amount of radium element and the same filter and diaphragm are employed and the same length of exposure made, a given treatment may be repeated with exactitude. Conditions vary widely in different patients, therefore the amount and quality of the radiations to be applied can be determined only by experience, and care should be taken not to carry the treatment too far.

Treatment in Acute Conditions. The presence of pharyngitis or laryngitis, so far as I have seen, does not contra-indicate the employment of radium. There need be no delay in the use of radium on account of the season of the year, or because of an acute stage in diseases that have their source in



FIG. 9. This cut shows a patient reclining comfortably in a Morris chair. With the back at the angle shown in the figure the position of the patient affords the physician an excellent view of the throat and is convenient for the application of the radium. Further, in this position the saliva does not readily collect in the mouth. The seat of the chair, with its cushion, is 19 inches from the floor; if the patient is very tall, a cushion on the arm of the chair, under the elbow, may be desirable for the person applying the radium.

the tonsils. The earlier the treatment is given the less opportunity will there be for the micro-organisms in the throat to do harm. Radium treatment of the tonsils is of great value, not only in promptly improving the condition of the patient in acute tonsillitis and shortening the attack, and in acute arthritis, but also in lessening the cardiac and renal complications that may accompany these diseases. In some cases the patient's general condition is an indication for the use of radium, even though the appearance of the tonsils does not suggest it.

Discharge from the Tonsils. Patients should report for observation eight to ten days after the first treatment, at which time discharge from the tonsils may be expected, and some non-caustic hypochlorite, such as chlorazene (about 1/10 per cent. solution) may be employed. Patients have been instructed, if they have any discomfort after treatment, to use as a gargle a level teaspoonful of salt in a tumbler of water. Irritating applications, such as argyrol, nitrate of silver, or tincture of iodine, should be avoided. Some kinds of tonsils diminish in size very strikingly within a few days, others very slowly. In cases where the tonsils are very large, a longer treatment than is necessary for the average case is desirable. A day or two after such a treatment, instead of the ordinary

discharge, a profuse one that may last for several days may follow, and the throat may be sensitive for a few days when cold, hot, or highly seasoned food is eaten. This should cause no alarm, it merely indicates that the desired result is being attained; this reaction has occurred in less than 1 per cent. of my patients. The compensation for this is, as a rule, more rapid reduction in the size of the tonsils. Treatment should be continued as long as there is any discharge or exudation from the tonsils.

Prompt Improvement after Radium Treatment. It might seem that any treatment which extends over several weeks would require waiting for improvement, but a striking feature of the method is that after the first treatment improvement in the general condition is often immediate, even before any change is apparent in the tonsils. The reports of patients suffering from poisons originating in the lymphoid tissue in the throat, of improved well-being, alertness instead of lassitude, and desire instead of disinclination for work, have been the rule.

Treating Children. As a rule, children coöperate readily. A young child may be kept from struggling or moving its arms by having the mother hold it on her lap, then placing the folded edge of a sheet under the chin and wrapping it two or

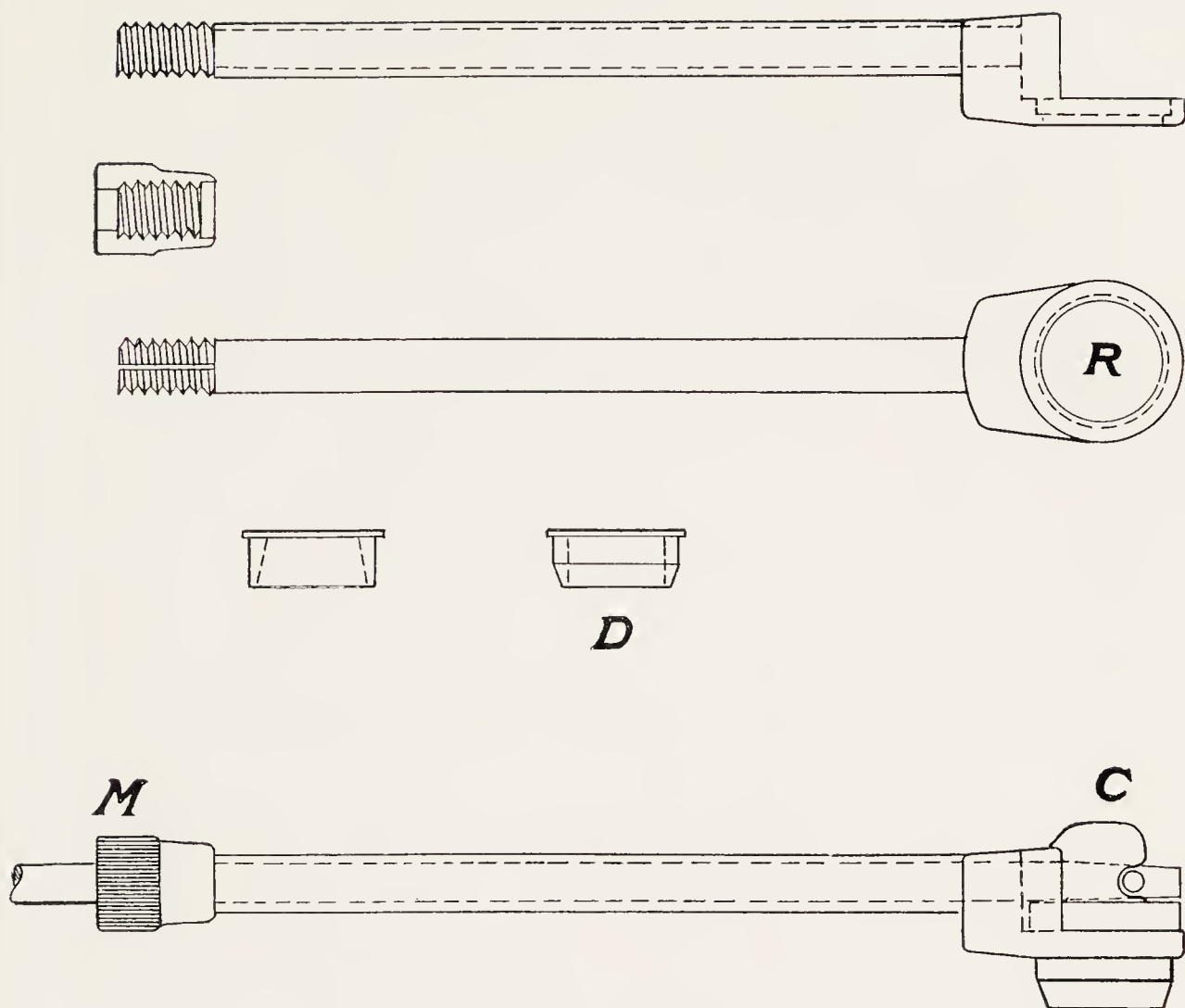


FIG. 10. (Full size except the tube, which is $\frac{1}{2}$ inch longer.) This figure shows the method of holding the diaphragms, which may be of different shapes and sizes, and two of which are shown in D. The filters are disks of aluminum, and they and the diaphragms are held in the ring R, which also acts as a large diaphragm to prevent too much spreading of the rays. On the left of the container C is a mass of gold, also seen to the left of R, which still further prevents the radiations from issuing in the direction of the handle. M is a nut with a milled head that clamps the split end of the tube, carrying the diaphragm and filter, to the rod at the end of which is the container. When the radium is to be used in the upper part of the pharynx, a higher diaphragm than that shown at D should be employed, in order to protect the soft palate. When the container is not in use its front is covered by a disk of gold 5 mms. thick held in the ring R.

three times about the child firmly, but not so tightly as to cause discomfort. A good initial dose for children is 38 mgs. of radium element, with a filter of aluminum 0.58 mm. thick, for five to ten minutes to each tonsil. For delicate children one treatment of five minutes to each tonsil may produce such improvement in their general condition that they will gain in strength and appetite, although there may not be much change apparent in the tonsils.

Applying Radium through the Skin. Radium may also be applied through the skin under the tonsil. When this is done, the usual short diaphragm is replaced by a tubular gold diaphragm about 15 mms. long, having walls 1 mm. thick, an internal diameter of 8 mms., and a filter of aluminum 1 mm. thick at the end to be applied to the skin. This end, directed upward, is held for fifteen minutes under the tonsil of an adult, and for about five minutes under that of a child. This method might be useful for treating the tonsils of patients who have scarlet fever. In some cases it may be desirable to apply the radiations both through the skin and inside the throat; in such cases the treatment should be given first on the inside in order to insure good drainage.

Permanency of Results. Radium treatment of the tonsils was begun in 1921 and the first article

on the subject, "Treatment of Hypertrophied Tonsils and Adenoids* by Radium; a Preliminary Statement," was published March 10, 1921.¹¹ Experience with 500 patients,† their ages ranging from three and one-half to eighty-six years, treated from 1921 to 1928,‡ inclusive, has shown that the method is perfectly safe, and the results far more permanent than after tonsillectomy. After sufficient experience, the adaptation of the amount of radium treatment to the individual patient is in the majority of cases not difficult; so far as I have been able to follow these patients, supplementary treatment has been necessary in only about 5 per cent. of the earlier cases in the group of 500, and less than that in those treated later; however, about two further radium treatments are a simple matter as compared with a second tonsillectomy. In order that such cases may not be overlooked, patients should be required to report for examination, say two or three months after the last treatment.

B. E., aged 19. History: Colds lasting several

*In 1908¹⁰ I made the following statement: "There is, I believe, another opportunity for the use of radium which I will only refer to in this paper, and that is the treatment of certain glandular structures. It seems to me that the attempt might well be made to treat adenoids by means of radium."

†It is of interest to note that a considerable number of patients were physicians, surgeons, or members of their immediate families, or nurses.

‡At this time I discontinued the treatment of the tonsils; as the efficacy and safety of radium treatment appeared to be well established, it seemed to me more important to devote my practice entirely to the use of radium in diseases of the eyes.

months; below par, very nervous and fragile, very easily tired; out of college because of ill health.

January 8, 1925, both tonsils were large, beyond pillars, left tonsil ragged; free discharge from crypts. Two treatments were given to the right tonsil with 55 mgs. radium element, with a filter of 0.6 mm. aluminum, on January 8 and February 2, of ten and eight minutes respectively, and on the same dates two to the left tonsil of ten minutes each. Throat so sensitive that it was necessary to use a spray of a 2 per cent. solution of cocaine. February 25 both tonsils much smaller; right tonsil behind the pillars, left larger than right. Slight reaction in both tonsils on the eighth and ninth days after second treatment; no congestion in throat. A third treatment, without the cocaine spray, of seven minutes to the right and eight minutes to the left tonsil, was followed by a vigorous reaction. The patient looked and felt much better, colour better, and she had lost her transparent look. March 27 the patient had had no colds during the winter, and during the past two days had driven an automobile one hundred miles each day. Her improvement continued and invalidism was a thing of the past. April 24: Some of the left tonsil still remained, about on a level with the pillars, somewhat firm and probably fibrous. November 10, 1925, her father reported that she was in college and doing well, and in August, 1926, that she had had none of her usual prostrating colds since radium treatment was given, and finished her college year in excellent

condition. April 4, 1927, a good report was again received, and a further good report in 1932.

The tonsils of the parents and of the sister of this patient were treated with good results.

F. S. W., aged 22. History of frequent attacks of tonsillitis, diphtheria during the winter of 1923-1924, and later another attack of tonsillitis.

On February 4, 1925, when the patient came to me for radium treatment, he had acute tonsillitis, both tonsils were greatly enlarged, nearly meeting, and the gland at the angle of the right jaw was swollen. Using 55 mgs. of radium element, with a filter of 0.6 mm. aluminum, a treatment was given of eleven minutes to the right tonsil and ten minutes to the left tonsil. On February 12, the gland was no longer swollen; the crypts of both tonsils were open and discharging, there was no soreness in either tonsil, no congestion in the throat, and the patient reported that he felt "first rate." No treatment was given. On February 25 the tonsils were much smaller, about on a level with the pillars, the crypts were open but not discharging, and there was no congestion anywhere in the throat. A second treatment was given, of ten minutes to each tonsil. On March 25 there was a slight discharge from the upper part of the right tonsil. A third treatment, of eleven minutes, was given to this tonsil; the left tonsil, which was behind the pillars, was not treated. The patient lived at some distance from the city and I did not see him again; as he was doing well, it seemed

sufficient to have him under the observation of his own physician, who reported to me on May 11, 1925, that the tonsils were small and the patient was in good condition. On April 14, 1927, upon inquiry, a good report was again received.

F. G. D., 33 years old. Occasional attacks of tonsillitis in the winter during the past few years. Below par and nervous. Tonsils not large. Right tonsil is especially inflamed; irregular in outline. Redness in fauces.

April 22, 1925, a treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, nine minutes to each tonsil. May 13, on the seventh day there was reaction on the right tonsil, lasting for ten days. He was conscious of the left side of the throat during the reaction on the right side. Appetite increased after the first treatment. May 26, a second treatment was given of seven minutes to the left and nine minutes to the right tonsil. June 19, no reaction on either tonsil. Right firm to palpation. A third treatment was given, nine minutes to each tonsil. August 27, throat looks well. No discharge on either tonsil. Small mass on left, probably fibrous. Patient feels "on his toes." July, 1927, he reported that the tonsils were in good condition. "Much better in every way."

H. J., 55 years old. Had pneumonia in the spring of 1925. Tubercular history. Has not had a well day for eight years. Right side of throat has been "raw" and congested. The left tonsil has not troubled her so much, but seems larger.

January 12, 1926, the first treatment was given with 55 mgs. radium element and 0.68 mm. aluminum, nine minutes to each tonsil. March 9, discharge from both tonsils. The patient reports that she is "walking on air." Has gained in weight. Has had grippe, but no throat trouble, and has never felt better in years. Colour better. A third treatment was given, of nine minutes to each tonsil. March 23, pharynx red and congested. A treatment was given to the pharynx, ten minutes with 26 mgs. radium element and a filter of 0.58 mm. aluminum. April 13, a fourth treatment was given, nine minutes to each tonsil. May 12, reaction and yellow discharge on both sides. A fifth treatment of nine minutes to each tonsil. June 10, a treatment of ten minutes was given to the pharynx. Tonsils very small. Patient "feels fine."

M. I. H., 39 years old. Has had intestinal disturbances for fourteen months. Tonsillitis years ago. General condition below par. Very nervous and apprehensive. Both tonsils large, ragged, cryptic and discharging.

January 15, 1926, a treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, of eleven minutes to the right and ten minutes to the left tonsil. Reaction and discharge on the ninth day, continuing for seven days. February 1, a second treatment was given with 55 mgs. radium element and a filter of 0.68 mm. aluminum, of nine minutes to each tonsil. February 11, the patient looks and feels better generally. February 16, less congestion. Some discharge

from the crevices around the tonsils. A third treatment was given, ten minutes to each tonsil. February 26, crypts open and discharging on both sides. Both tonsils much smaller. Pharyngeal wall red and congested. A treatment with 26 mgs. radium element and a filter of 0.58 mm. aluminum, of ten minutes, was given to the pharynx. March 16, his physician is "amazed at the improvement in his tonsils." A second treatment of ten minutes was given to the pharynx. The patient reports that his entire household has been down with colds lasting more than a week, but he went to bed for one day only and thinks that was mostly fright. April 12, throat clean; tonsils smaller. Patient's general condition much improved. Nerves better. Has had no intestinal trouble since two weeks after the first treatment.

B. M., 71 years old. Sore throat for years. Tonsillitis one year ago. Tonsils ragged, cryptic and discharging. Both tonsils small.

February 19, 1926, a treatment was given with 55 mgs. radium element and a filter of 0.29 mm. aluminum, four minutes to each tonsil; with a filter of 0.58 mm. aluminum, five minutes to each tonsil. March 1, she reported that the right side has been less troublesome since radium treatment. Less discomfort than for years. With 26 mgs. radium element and a filter of 0.58 mm. aluminum, a treatment of ten minutes was given to the pharynx, which was rough, red, and discharging. March 15, a treatment was given with 55 mgs. radium element and a filter of 0.58 mm. alumi-

num, ten minutes to each tonsil. Practically no tonsil on the right side. Palpation shows a small tab of tonsil low down on the left side. April 20, a treatment was given with 26 mgs. radium element of ten minutes to the pharynx. May 11, tonsils clean and free from discharge. Pharynx still somewhat rough and discharging. October 19, throat entirely free from soreness and discomfort. Feels like "a different woman."

H. N., 32 years old. Tonsillitis when a child. Colds and sore throat in the winter of 1926-27. Below par. Under weight. Tonsils very rough and ragged.

April 29, 1927, the patient was given the first treatment, with 55 mgs. radium element and a filter of 0.58 mm. aluminum, ten minutes to each tonsil, and on May 18, a second treatment of ten minutes to each tonsil. July 29, no reaction on either side. Discharge on both tonsils. Throat more comfortable. Feeling of "having to get something out of the throat all the time" gone. A third treatment was given, of ten minutes to each tonsil. October 7, discharge on both tonsils; pharynx slightly rough. Patient "feels great." A fourth treatment was given, through the skin, with 55 mgs. radium element and a filter of 1.29 mms. aluminum, for fifteen minutes to each tonsil. December 27, right tonsil slightly congested and there was some discharge. Left tonsil clean and free from discharge. Crypts stretched open. A treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, nine minutes

to the right tonsil, and with 26 mgs. radium element and a filter of 0.08 mm. mica and 0.4 mm. aluminum, ten minutes to the pharynx, which was rough and discharging. This patient has had no colds and no sore throats since radium treatment was begun, and "feels fine generally."

C. C. A., 58 years old. General condition below par. Glands on right side of neck are sensitive. Sensitiveness in right ear. Tonsils rough, cryptic and discharging. Pharynx rough, red and discharging.

November 8, 1927, a treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, nine minutes to each tonsil. December 9, throat feels better. Glands of neck less sensitive. Feels better all over. Tonsils beginning to discharge. A treatment with 26 mgs. radium element and a filter of 0.08 mm. mica and 0.4 mm. aluminum, of ten minutes, was given to the pharynx. January 6, 1928, throat feels very much better. No trouble in glands. A second treatment was given of nine minutes to each tonsil. January 13, the patient reports that he "feels a different person." The tonsils are smaller, but are still large. A second treatment of ten minutes was given to the pharynx. April 2, has been south for two months. Feels 75 per cent. better. A third treatment was given of nine minutes to the right and eight minutes to the left tonsil. Some discharge on each tonsil. Pharynx looks much better. Hears better. Glands less sensitive. April 27, has had a severe grippy cold, but neither the tonsils nor the

pharynx were involved. A fourth treatment was given with 55 mgs. radium element and a filter of 1.29 mms. aluminum, fifteen minutes to the right and twelve minutes to the left tonsil, through the skin. June 1, both tonsils are small, pale and clean. Pharynx pale and smooth.

P. C. F., 54 years old. Sore throats for years. Always hoarse in damp weather. Tonsils very large, meeting in throat. Operation contraindicated because of cardiac condition.

March 15, 1927, to May 25, 1927, with 55 mgs. radium element and a filter of 0.58 mm. aluminum, three treatments of ten minutes were given to each tonsil; with 26 mgs. radium element and a filter of 0.08 mm. mica and 0.4 mm. aluminum, two treatments of ten minutes each were given to the pharynx, which was rough and discharging. On June 15, 1927, she reported that she feels a different woman since radium treatment. Was able to motor from Maine today. Before treatment she had to have a drawing-room so she could lie down.

K. B., 44 years old. Tonsillitis one week before. *Very* nervous. Whole throat red and congested; tonsils small.

December 17, 1926. A treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, ten minutes to each tonsil. January 12, 1927, has felt better all over since the third day after treatment. Throat feels better; more room in throat. A second treatment was

given of ten minutes to each tonsil. February 9, slight discharge on tonsil. A third treatment was given of nine minutes to each tonsil. March 2, tonsillar area clean and free from discharge. Pharynx rough and discharging; the pharynx was given a treatment of ten minutes with 26 mgs. radium element and a filter of 0.08 mm. mica and 0.4 mm. aluminum. November 30, whole throat less congested. Upper pharyngeal wall still rough. A treatment was given with 26 mgs. radium element, and a filter of 0.08 mm. mica and 0.4 mm. aluminum of nine minutes in the nasopharyngeal passage. The patient is less nervous. March 5, 1930, palpation shows that the tonsils are not enlarged.

Palpation. Palpation, with one forefinger outside and under the tonsil and the other in the mouth, is of great value in ascertaining the size and condition of submerged tonsils, which should be treated when the history is suggestive, and also in determining whether or not a portion of the tonsil remains after treatment. Palpation should always be done.

Fibrous Tonsils. If the tonsils are composed chiefly of fibrous tissue, as shown by their firmness on palpation, they may still remain quite large after the removal of the lymphoid tissue, as the radiations from radium do not act upon fibrous tissue. In these cases, the patient should be told that radium will not cause the tonsil to disappear,

but will get rid of the infected tissue. If such tonsils are in the way mechanically, they may be removed by other means. Such removal has seemed to me advisable in only two cases. In another case, in which a considerable amount of fibrous tissue had been left, there had been no change in the size of the tonsils after more than three years, but during this time the patient had been free from the colds and tonsillitis to which she had been subject before radium treatment was given, although other members of the household had had such attacks.

Arthritis. Radium treatment may be given for alleviation as well as in the hope of permanent relief, or as a test if there is doubt as to the origin of the arthritis. It may also be used as a test in other cases in which the diagnosis is obscure, where the tonsils might be suspected, but tonsillectomy would not be justified. In acute arthritis improvement is often very prompt; in subacute and chronic cases it of course takes place more gradually. It is well to bear in mind that the tonsils should not be disregarded as a source of arthritis because apparently they are not enlarged or because they are submerged.

K. F., aged 47 years, had arthritis of the upper spine and occasional attacks of tonsillitis (a mild attack during the winter of 1921-22). In Decem-

ber, 1921, she had intestinal influenza, followed by arthritis of the knee, which was in splints for weeks. She used a wheeled chair, then crutches, then a cane. The tonsils were slightly beyond the pillars.

April 22, 1922, she was given the first treatment, with 26 mgs. radium element, ten minutes to each tonsil, and three days later reported that she felt better. The second treatment, nineteen days afterward, was given to the left tonsil only. A week later her knees were better; she could walk better, go down stairs, and turn her head more easily. On June 29 she could go without a cane part of the time and had no trouble with her knee unless she exercised it too much. She reported, "I have not had a particle of discomfort from the treatment, not even a scratchiness in the throat, as I might have had from a cold." Treatment was interrupted during the summer, then five more treatments were given to the right and four to the left tonsil.

Her general condition was much improved, and she was able to go without a cane except when walking on very rough places. The tonsils were apparently very small, behind the pillars. Two years after the first treatment she had not had an attack of tonsillitis.

H. M. A., aged 42 years, a district nurse, had a history of repeated attacks of tonsillitis. She had had many colds and sore throats, and her throat was swollen and hoarse during practically the whole winter of 1921-22. She had had pains in the

finger-joints and arm; could get through her day's work, but was tired at night. Both tonsils were three-eighths of an inch beyond the pillars.

On May 11, 1922, she was given one treatment with 26 mgs. radium element, ten minutes to the right tonsil, and on May 11 and 25, two of ten minutes each to the left tonsil. June 6, she reported great improvement in health and strength, and that she felt much younger. She had no pain whatever in joints, elbows or fingers. She failed to report in September, as directed, because she felt perfectly well. On January 4, 1923, she had an attack of acute arthritis in her left elbow; the next day it was so swollen, painful and hot that she could not use her arm for telephoning. On January 5 she was given a treatment with 38 mgs. radium element and a filter of 0.58 mm. aluminum, fifteen minutes to each tonsil. On the following day she was able to use her arm, comb her hair and dress herself. Five more treatments were given to the right and seven to the left tonsil, with 38 mgs. radium element. Two years after her first treatment the patient reported that she had had no arthritis since the attack of January 4, 1923, and no tonsillitis since radium treatment was begun.

J. L. F., 46 years old. Has had rheumatism. General condition below par. Tonsils small.

January 8, 1925, a treatment was given with 55 mgs. radium element, and a filter of 0.58 mm. aluminum, of ten minutes to the right, and eleven minutes to the left tonsil. February 2, a second

treatment of eleven minutes was given to the left tonsil. Has gained ten pounds. Feels much better. More "pep." Neuritis and rheumatism gone.

S. B., aged 60. History: Colds; arthritis in arm; attack of angina pectoris; infection in left ear. His physician would not consent to tonsillectomy because of the heart.

On July 13, 1925, both tonsils were apparently small. Two treatments were given with 55 mgs. radium element, with a filter of 0.6 mm. aluminum, on July 13 and August 3, of five and six minutes to the right tonsil, respectively, and of six and seven minutes to the left tonsil respectively. September 15 the patient felt better; the lower portion of the left tonsil was rough and discharging and was given a treatment of six minutes. October 9, some firmness in the left tonsil; throat feels better; colour better and arthritis in arm diminished; general condition much improved. December 29, the pharyngeal wall, which was rough and somewhat coated, was given a treatment of six minutes with 26 mgs. radium element. January 5, 1926, the patient reported that the pharyngitis was relieved. A third treatment of eight minutes was given to the right tonsil, and a fourth of seven minutes to the left tonsil, with 55 mgs. radium element. January 15, pharynx slightly coated, and was given a second treatment of six minutes with 26 mgs. radium element. February 2, a slight discharge from the pharynx, which is much smoother and less congested. The throat has felt much better since the pharynx was

treated. Tonsils clean and very small; arthritis in arm gone; cardiac trouble better and general condition markedly improved. When last heard from, about a year later, this improvement still continued.

B. J., 50 years old. Arthritis in fingers for five years; in ankles since March, 1926, after tonsillitis. Tonsillitis four times; left tonsil removed. Tonsils fairly large, rough, cryptic and discharging.

August 2, 1926, the first treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, eight minutes to each tonsil. August 27, some discharge on each side. Less stiffness in finger joints. A second treatment was given of nine minutes to each tonsil. October 5, crypts wide open; right discharging freely, not so much discharge from left. A third treatment was given, nine minutes to each tonsil. December 2, a treatment with 26 mgs. radium element and a filter of 0.08 mm. mica and 0.4 mm. aluminum, of twelve minutes, was given to the pharynx, which was coated and rough. December 30, the right tonsil was clean; slight discharge on left. The pharynx was red and discharging, and was given a second treatment of twelve minutes. Has had no trouble with the joints since the pharynx was treated, in spite of having had grippe. The nasopharynx is better. April 27, 1927, has had some arthritis. Right tonsil clean, some discharge on left. A treatment of nine minutes was given to the left tonsil. February 10, 1930, throat clean and smooth; no

redness; palpation shows no evidence of tonsil on either side.

M. F., 47 years old. Arthritis in one finger and both knees. Quite deaf in right ear; noises in right side of head.

October 14, 1926, the first treatment was given with 55 mgs. radium element and a filter of 0.58 mm. aluminum, eight minutes to each tonsil. October 22, the crypts were open and discharging. The noise in the head ceased in the night five days after the first treatment. Feels as if the congestion on the right side had diminished. Hearing improved. November 4, slight discharge on each tonsil. A second treatment was given of ten minutes to each tonsil. November 26, she reports that she can hear people talking on the telephone downstairs, which she could not do before. A third treatment was given, of ten minutes to each tonsil. December 10, feels much better. Can step out more freely. A treatment with 26 mgs. radium element, and a filter of 0.08 mm. mica, of ten minutes, was given to the pharynx, which was rough and discharging. December 17, feels twenty years younger. A fourth treatment, of ten minutes, was given to each tonsil. January 5, 1927, she reported that her friends do not know her, she looks so much better. "On her toes" all the time. Tonsils clean, and colour healthy.

M. C. J. Had arthritis for two months; pain and swelling; could not sleep at night. Tonsils small and innocent looking.

March 2, 1925, the first treatment was given, with 55 mgs. radium element and a filter of 0.58 mm. aluminum, for ten minutes to each tonsil. March 23, has not been conscious of throat; joints are better. A second treatment was given, of eleven minutes to each tonsil. April 13, no reaction. A third treatment was given, of ten minutes to each tonsil. Arthritis ceased after the first treatment.

M. L. L., 41 years old. Scarlet fever at 15 years, followed by trouble with throat for four years. Arthritis for six months. Neuritis in back and thumbs. Throat congested; tonsils infected.

June 26, 1925, a treatment was given with 55 mgs. radium element, and a filter of 0.58 mm. aluminum, eight minutes to each tonsil. July 16, profuse discharge on right tonsil; slight discharge on left. A second treatment was given of eight minutes to each tonsil. Felt much more room in the throat. August 6, a third treatment was given of eight minutes to the right, and seven to the left tonsil. August 27, a fourth treatment of eight minutes to each tonsil. September 17, no discharge on right tonsil; slight discharge on left. A treatment of seven minutes was given to the left tonsil. October 16, has felt less nervous. General health much improved. The patient reported, "Radium treatment has made a new woman of me."

If arthritis is not relieved by radium treatment of the tonsils, some other source should be sought. This is illustrated by the following case:—

Miss Z. had recovered from an attack of arthritis but had an acute tonsillitis when I gave her radium treatment. After one application the tonsils were reduced to a very small size and she recovered from the tonsillitis. Four weeks later the patient had another attack of arthritis, a severe one, and, without my being consulted, tonsillectomy was done, the operation being facilitated by the small size of the tonsils. In less than three weeks after the operation she had another attack of arthritis, which was followed by still another in about four weeks. A Roentgen ray examination made at this time showed abscesses around two of the teeth. When last heard from, three months after the removal of the teeth, she had had no further attacks of arthritis.

This case suggests that, without resorting to tonsillectomy, we may be able to infer by the application of radium whether or not certain complications have their origin in the tonsils.

Another patient was not relieved either by moderate radium treatment or subsequent tonsillectomy.

Hay Fever. Radium treatment of the tonsils may be of service in relieving or preventing attacks of hay fever.

P. F. H., 50 years old. Subject to colds and tonsillitis. Arthritis in knees; muscular rheumatism in head. Has hay fever from about the middle of August until the first heavy frost. Has had

asthma, bronchitis, tonsillitis, pharyngitis, and laryngitis, all at once.

April 22, 1926, with 55 mgs. radium element, and a filter of 0.58 mm. aluminum, a treatment of nine minutes was given to each tonsil. April 30, she reported that her throat was better since radium treatment than it had felt for years. May 17, throat looks cleaner, only slight discharge on each tonsil. A second treatment was given of nine minutes to each tonsil. June 7, no reaction. Slight discharge on each side. A third treatment was given, of eight minutes to each tonsil. Pharynx on left side red and discharging; a treatment of four minutes was given with 26 mgs. radium element and a filter of 0.08 mm. mica and 0.4 mm. aluminum. July 16, throat feels more comfortable. Is able to sing again since radium treatment. Tonsils much smaller. A treatment was given with 55 mgs. radium element and a filter of 0.29 mm. aluminum, of seven minutes to each tonsil. September 4, with 55 mgs. radium element and a filter of 0.58 mm. aluminum, a treatment of nine minutes was given to the left tonsil; with 26 mgs. radium element, and a filter of 0.08 mm. mica and 0.4 mm. aluminum, a treatment of ten minutes was given to the pharynx, which was rough and coated. October 22, throat smooth and clean. Arthritis gone. Patient in good condition generally this autumn for the first time in years. No hay fever, although she has been to all the towns where usually she has had it, in some of which it began as soon as she entered. In March, 1928, she reported that she had no hay

fever during the summer of 1927, although she had grippe and bronchitis.

Radium Treatment of Tonsils after Tonsillectomy or Tonsillotomy. Thirty patients who had had tonsillectomy and seven who had had tonsillotomy done some months or years before, have come to me for radium treatment. In such cases a filter of aluminum 0.3, 0.5, or 0.6 mm. thick, according to the size of the tonsil, and a diaphragm also adapted to its size, should be used, and a shorter treatment given, but experience should be the guide in regard to the details of procedure.

Lymphoid Tissue in the Pharynx. It is important to realize that treatment of the pharynx as well as of the tonsils may be necessary. Of the 500 cases of tonsils treated with radium, involvement of the pharynx was present in 72 of 103 consecutive cases.

The radium is applied in a pure gold container smaller (8 mms. in diameter) than that used for the tonsils, which holds 26 mgs. of radium element with a cover of 0.4 mm. aluminum, and is screwed onto a silver rod of such small diameter for about 3.5 cms. ($1\frac{3}{8}$ inches) a little below where the two are joined, that this part of the rod can be bent in any desired direction. The container is held at a

little distance from the portion of the pharyngeal walls to be treated, not only to avoid touching, but also to allow the electrons to spread and thus cover a larger area, and is moved about from six to ten minutes, according to the extent of the diseased surface. These treatments are carried out under the same illumination as is used for the tonsils. When it is desired to apply the radiations upwards, this can be done by having on the end of a rod an instrument such as is used to lift the eyelid. Directly under this on another rod is the radium container, so arranged that the container can be slid a little beyond the upper instrument, after the latter has drawn the soft palate forward.

Two or three treatments, sometimes only one, are sufficient. Improvement is marked, and a rough, discharging pharyngeal wall may become smooth and free from congestion, whereas the usual local applications are palliative rather than curative. Some of my patients, whose tonsils were not infected, have obtained relief from arthritis and have shown general improvement after radium treatment of the pharynx.

For example, a patient whose tonsils I had treated three and one-half years before, returned thinking she had a recurrence. On examination I found that what remained of the tonsils was not the cause of her condition, but that the pharynx

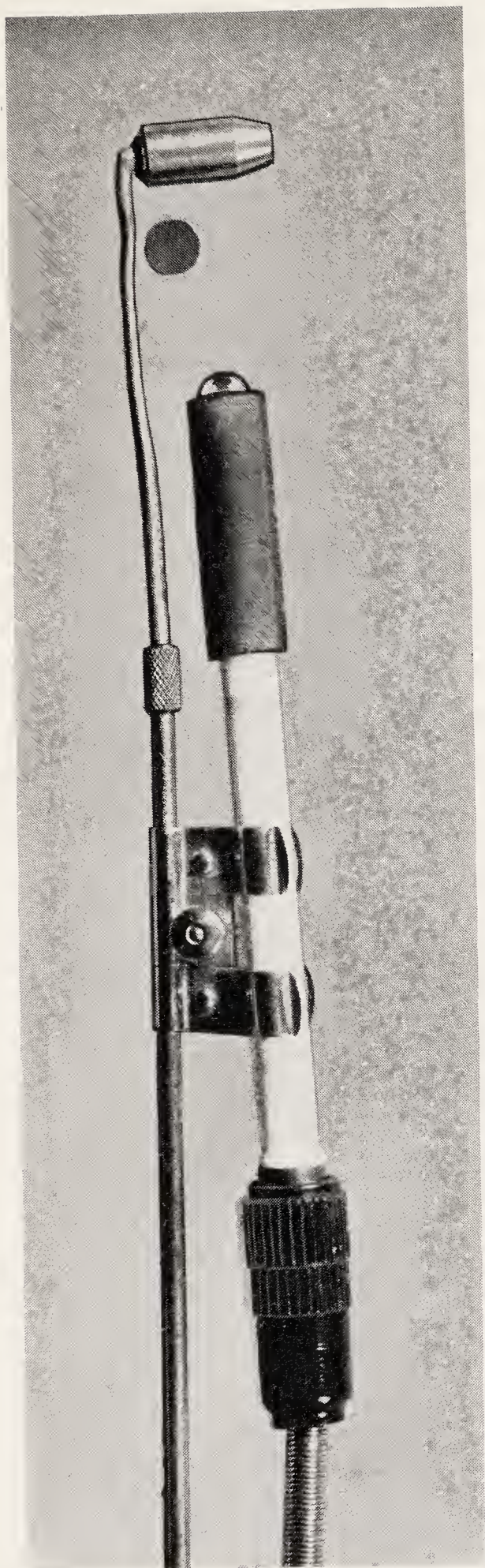


FIG. 11. Instrument for treating the Eustachian tube.

needed treatment, which was given, and which was followed by relief from arthritis. Another patient, who had been free from tonsillitis, arthritis and colds for more than three years after radium treatment of the tonsils, had a return of arthritis and a sore throat. Examination showed that the tonsils were pale, clean and free from congestion, but that the pharynx was red, rough and discharging, and the lateral pillars congested. After the second treatment of the pharynx with radium there was no arthritis nor stiffness nor pain of any sort, but as there was still some discharge from the pharynx, a third treatment was given.

Lingual Tonsils. In treating lingual tonsils, the container is held on a rod, the end of which has been so bent that the rays issue downward and forward, and should be near but need not touch the tonsil. It is advisable not to push the treatment of lingual tonsils as rapidly as may be done in faucial tonsils, because all the food must pass over the tongue. Should the discharge that takes place some days after treatment trickle down to the trachea and cause coughing, relief may be had by spraying the parts with peroxide of hydrogen, as washing off the discharge stops the cough temporarily.

Eustachian Tube. For treating the region about the Eustachian tube, an instrument such as that shown in Fig. 11 is useful.

Other Methods of Applying Radium. Other ways of applying radium have been used, for example: putting radium into small hollow platinum needles and inserting these into the tonsils. The objections to this method are

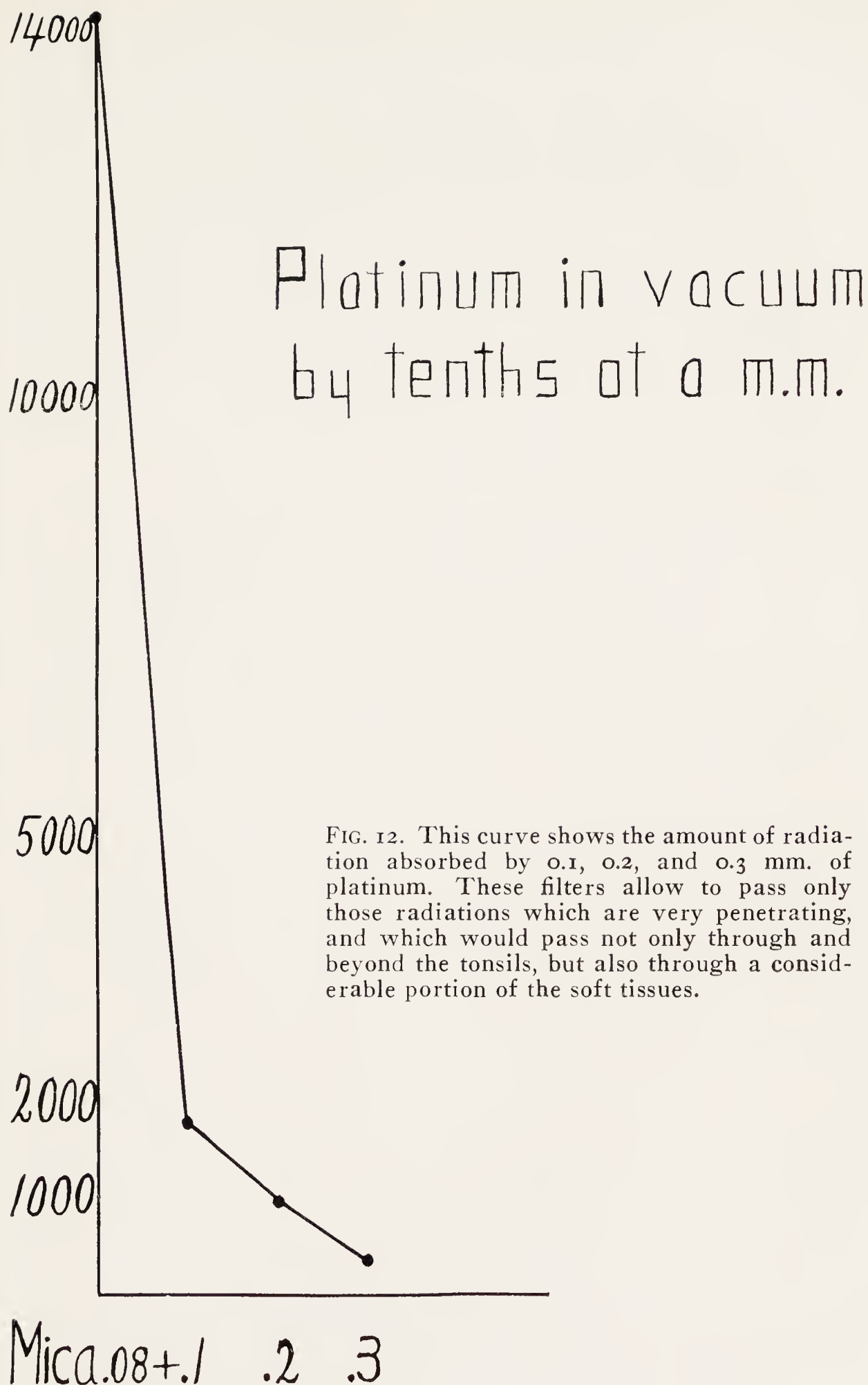
First, that the insertion of a needle into an infected tonsil might give rise to a serious general infection.

Second, that these needles can not be used for treating the lymphoid tissue in other parts of the throat.

Third, that the platinum walls of the needles have been shown by measurement to absorb the radiations which are most effective in the treatment of the tonsils. (See Fig. 12. Cf. Fig. 3.)

Safety of Radium. In the early years of this century and soon after the possibility of serious results from the use of the Roentgen rays* had been recognized, it was natural that there should be considerable apprehension in regard to burns from radium. Experience and judgment should guide the physician in giving an amount sufficient to cause healing without over-exposure which

*The record of 445,000 patients examined or treated in the X-Ray Department at the Boston City Hospital, from 1896 to 1930, inclusive, without a burn to any one of them, shows that the Roentgen rays may be used without harm.



would result in irritation or a burn. At the same time, if radium is used timorously, good results will not follow or will come only after unnecessarily prolonged treatment. The application of pure radium salts, when used properly and in suitable amount, is a harmless, painless, efficient method. As with other efficient remedies, the use of radium may be followed by success in the hands of one practitioner and by failure in those of another.

The uniformity of output, insuring accuracy of dosage, the selection of the amount and quality of the radiations applicable to a given condition, and limitation to the part it is desired to treat, make radium, *when properly used*, an even safer agent than the Roentgen rays. In thirty years' experience in the use of radium, no harmful effects have resulted to any patient, to my assistant or to myself.

BIBLIOGRAPHY

¹COMMITTEE ON THE COST OF MEDICAL CARE. The Extent of Illness and of Physical and Mental Defects Prevailing in the United States. Published in Washington, D. C.

²EMERSON, HAVEN. Economic Aspects of Heart Disease. Trans. Cong. Am. Phys. & Surg., 14: 27, 1928.

³HALSEY, ROBERT H. Heart Disease in Children of School Age. J. A. M. A., 77: 673-674 (August 27) 1921.

⁴RHOADS, PAUL S. and DICK, GEORGE F. Efficacy of Tonsillectomy for the Removal of Focal Infection. J. A. M. A., 91: 1149 (October 20) 1928.

⁵ROGERS, JAMES FREDERICK, Chief of Division of Education and School Hygiene. Physical Defects of School Children, School Health Studies No. 15. United States Department of the Interior, Office of Education, 13-15, 1929.

⁶WILLIAMS, FRANCIS H. Note on the Use of the Fluorometer to Estimate the Proportions of Beta and Gamma Rays Given off from Radium Salts. Boston M. & S. J., 149: 691 (December 17) 1903.

⁷Some of the Physical Properties and Medical Uses of Radium Salts; with Report of Forty-two Cases Treated by Pure Radium Bromide. Read at the meeting of the Boston Society of Medical Sciences, December 15, 1903. Med. News, 84: 241-246 (February 6) 1904.

⁸A Comparison between the Medical Uses of the X-rays and the Rays from the Salts of Radium. Read at the annual meeting of the Boston Society for Medical Improvement, January 18, 1904. Boston M. & S. J., 150: 206-209 (February 25) 1904.

⁹Notes on Radium: Production of the Gamma Rays from the Beta Rays of Radium; Use of Radium in Some Diseases of the Eye. Boston M. & S. J., 150: 559-561 (May 26) 1904.

¹⁰Early Treatment of Some Superficial Cancers, Especially Epitheliomas, by Pure Radium Bromide rather than Operation or X-rays. Presented, with demonstrations of more than 20 patients at the Surgical Section, Massachusetts Medical Society, June 9, 1908. Med. Communications Mass. Med. Soc., 21: 261-276, 1908. J. A. M. A., 51: 894-897 (September 12) 1908.

¹¹Treatment of Hypertrophied Tonsils and Adenoids by Radium; a Preliminary Statement. Boston M. & S. J., 184: 256-257 (March 10) 1921.

¹²The Treatment of Tonsils by Radiations from Radium Salts instead of Operation; 101 Cases. Read at the meeting of the Surgical Section, Massachusetts Medical Society, June 13, 1922. Boston M. & S. J., 187: 412-416 (September 14) 1922. Trans. Asso. Am. Phys., 37: 204-212, 1922.

¹³Traitement de l'hypertrophie amygdalienne par la curie-thérapie. Paris méd., 47: 110-113 (February 3) 1923.

¹⁴The Use of Radium Radiations in the Treatment of Tonsils: a Further Report. Trans. Asso. Am. Phys., 38: 430-432, 1923. Am. J. Med. Sci., 168: 18-35 (July) 1924.

¹⁵Reminiscences of a Pioneer in Roentgenology and Radium Therapy, with Reports of Some Recent Observations. Am. J. Roentgenol., 13: 253-259 (March) 1925.

¹⁶Radium in Some Diseases of the Eye as Illustrated by its Use in Opacity of the Cornea. Trans. Asso. Am. Phys., 40: 348-350, 1925.

¹⁷Radium Treatment of Tonsils and Other Lymphoid Tissue in the Throat. Am. J. Roentgenol., 19: 334-340 (April) 1928.

¹⁸Note on Radium Treatment of Infected Lymphoid Tissue in the Tonsils and Pharynx Especially in Acute Rheumatic Fever. Trans. Asso. Am. Phys., 43: 234-235, 1928.

¹⁹Note on the Use of Radium Since the Autumn of 1903. Trans. Asso. Am. Phys., 45: 434-436, 1930.

²⁰The Use of Measured Amounts and Suitable Quality of Radium Radiations in Opacity of the Cornea, Cataract, and Other Diseases of the Eye. Presented in Abstract at the Third International Congress of Radiology held in Paris, July 27-31, 1931. Privately Printed, May, 1933.

²¹WILLIAMS, FRANCIS H. and ELLSWORTH, SAMUEL W. Treatment of Superficial Skin Cancers by Pure Radium Bromide. Med. and Surg. Reports, Boston City Hospital, 16. s., 1913.

²²Treatment of Superficial New Growths by Pure Radium Bromide. J. A. M. A., 60: 1694-1697 (May 31) 1913.

INDEX

- Absorption of beta rays (electrons)
 by soft tissues, 7, 8, 18, 19
 By water a standard for absorption by soft tissues 16, 17, 19
 Of electrons by different parts of the eye 43, 55
 Of electrons by tonsillar tissue 76, 77
- Acne 11, 24
- Acute tonsillitis 85
- Adaptability of method of treating tonsils 77, 78
- Adenoids 88
- Adhesive plaster 21, 41, 46
- Alpha particles 4, 5
- Analgesic action of gamma rays 30, 34
- Angiomas 24
- Arthritis 67, 85, 98, 108, 109
- Atomic weight of radium 4
- Bacteria 67, 68
- Bactericidal action of radium 68, 69
- Becquerel rays 3
- Bémont, M. 4
- Beta rays 4, 6, 7, 8, 9
- Boston City Hospital 6, 110
- Brass plates for measuring absorption of radiations by water 17
- Breast, new growths of 12, 33
- Burns, radium 9, 11, 22, 34, 110, 111
 Roentgen ray 33, 110
- Callus 24
- Cataract 54
 Anterior capsular 55
 Economic value of radium treatment 59
 Filters in treatment 56
 Illustrative cases 56, 57, 58, 59
 Importance of early treatment 60
- Radium treatment 54
 Summary of cases 60
 Usual treatment 54
- Catarrh, spring 37
- Children, treating tonsils of 86, 87
- Colds 70
- Comparison of radium and Roentgen rays 9, 10, 11, 75
- Conjunctiva, lipoma of 44
- Container, radium 11, 20, 40, 79
- Cornea 38, 49, 50
 Fluorescence caused by radium 39
 Resistance to radiations 49
 Short exposures in treatment of 50
- Corneal opacity 48, 49
 Caused by burns 53
 First successful use of radium in 1904, 48
 Illustrative cases 50, 51, 52
 Interstitial forms 52
 Summary of cases 52
 Superficial forms 52
- Corneal ulcers 50, 51, 53
- Corns 24
- Cornu cutaneum 24
- Cumulative effect of radium 38
- Curves of measurements of radium 14
- Curie, Mme. 3, 4, 5, 6
- Curie, Professor 4
- Dark room for measuring radiations 14
- Davidson, Sir J. MacKenzie 37
- Deviation of radiations from radium by electromagnet 5, 7
- Diabetic patients, treatment of eyes of 59
- Diaphragms 21, 22, 40, 41, 49, 83, 84, 87
 For employing different amounts of radium from the same container 21, 22, 40

- Diminution of gamma rays by lead cone 23
- Discharge from tonsils 85, 86, 109
- Discovery of radium 3, 4
- Dosage 6, 75
- Ear, diseases of 69, 70
- Early treatment of cataract, importance of 60
- Ectropion 47
- Eczema 11, 24
- Electromagnet, deviation of radiations by, 5, 7
- Electrons 4, 18, 38, 43, 49, 50, 83, 108
- Epidermoid carcinoma 12
- Episcleritis 38
- Epithelioma 24, 25, 26, 27, 28, 29, 33
- Epitheliomas resulting from Roentgen ray burns 33
- Eustachian tube 70, 110
- Experiments with beta and gamma rays 6, 7, 8, 9
- Eye, absorption of radiations by different parts of 43, 55
- Eyelids, new growths of 46
- Eyes, diseases of 37, 38, 39
 - Field of radium in diseases of 39
 - Improvement following radium treatment of tonsils 64
- Feeble patients 31
- Fibrous tissue 19
 - Tonsils 97, 98
- Filters 7, 16, 18, 23, 38, 43, 55, 56, 83, 84, 87, 107
- Fluorescent screens 7, 8, 13, 14, 15, 16, 17
- Fluorometer for measuring radium 8, 13, 15, 17
 - For measuring Roentgen rays 6
- Frequency of treatment 22, 38, 84
- Gamma rays 4, 5, 6, 7, 8, 9, 23, 30, 34, 43, 83
 - As analgesic 30, 34
 - Diminished by lead cone 22, 23
 - Therapeutic action of 8, 9
- Glands, new growths of 32
- Glass tube for measurements in vacuum 15, 16, 17
- Gold as a protection for radium 20, 40
- Hay fever 105, 106
- Heart disease 69, 70, 71, 85
- Hemangioendothelioma 24
- Hypopyon ulcers 38
- Improvement, prompt after radium treatment 10, 27, 28, 60, 63, 86
- Increase of electrons by lead cone 23
- Indolent growths 31
- Industries, loss of time in 70
- Inoperable growths 31
- Instruments for applying radium 20, 40, 41, 42, 79, 80, 81
- Ionization 3, 13, 23
- Keloids 11, 24
- Keratoses 24
- Keratitis 38
- Lamp for illumination of throat 80
- Laryngeal mirror 80, 81
- Laryngitis 84
- Lead cone for treating superficial lesions 22, 23
 - Plate as protection for eyes when treating lids 46
- Length of treatment 21, 22, 50, 56, 84, 87, 107, 108
- Lens 38, 43, 54, 55, 56
- Lid retractors 41
- Limitation of radiations 21, 40, 77, 111
- Lingual tonsils 109
- Lip, epithelioma of 26, 27
- Lipoma of conjunctiva 44
- Lumbago 69
- Lupus vulgaris 11, 24
- Lymphoid tissue in pharynx 107, 108, 109
 - In throat 67, 68, 71, 76, 86, 97
- Measurements 13, 14, 15, 16, 17, 43, 55, 76

- Of absorption by different parts of eye 43, 55
- Of absorption by tonsillar tissue 76
- In vacuum 15, 16, 17
- Melanotic sarcoma 25, 46
- Method of treatment 20, 21, 22, 43, 83, 84
- Moles 24
- Mouth, new growths of 32

- Needles, radium 110
- Neuralgia 34, 69
- Neuritis 69
- Nevi 24

- Other forms of treatment 32, 46, 54, 73, 74
- Methods of applying radium 110

- Palpation of tonsils 97
- Patients of low vitality 31
- Old and feeble 31
- Penetration of beta rays (electrons) 7, 8, 18, 19
- Of gamma rays 8
- Permanency of results 25, 28, 29, 60, 87, 88
- Pharyngitis 84
- Pharynx, lymphoid tissue in 107, 108, 109
- Photographic action 3, 13, 23
- Physical properties of radium 4, 5, 6
- Pitchblende 3, 4
- Plaster, Adhesive 21, 41, 46
- Platinum needles 110
- Precautions 11, 76, 77
- Prescription for use of radium 18
- Prevalence of infected tonsils 69, 70
- Proctor, Professor Bernard E. 49
- Prompt improvement after radium treatment 10, 27, 28, 60, 63, 86
- Proportion of radiations 8, 17, 18, 43, 76
- Protection of surrounding parts by ZO plaster 21
- Psoriasis 9, 11, 24

- Pterygium 38
- Pure radium salts essential for best results 22

- Quartz lamp for examination of eyes 42

- Rabbit's eye, exposure to radium of 49
- Radiations, selection of suitable 6, 19, 43, 44, 50, 56, 76, 78, 111
- Radioactivity 3
- Radium after other forms of treatment 28, 29, 32, 73, 107
- Bromide 4, 6, 20
- Burns 9, 11, 22, 34, 110, 111
- Chloride 4, 5
- Discovery of 3, 4
- Element, reduction of amount by diaphragms 21, 22, 40
- In recurrences 33
- Needles 110
- Physical properties of 4, 5
- Prescription for use of 18
- Sulphate 4, 79
- Reaction of tissues to radium 19, 73, 97
- Recurrences after other forms of treatment 33, 73
- After radium treatment 33
- Renal complications 85
- Retina 38
- Retinitis pigmentosa 62, 63
- Rheumatic fever 71
- Heart disease 71
- Rheumatism 69, 71
- Rodent ulcer 11, 25
- Roentgen ray burns, radium treatment of 33
- Rays and radium, comparison of 9, 10, 11, 75
- Rollins, Dr. William 5
- Routine examination of throats 72
- Rubber cot for cleanliness 20, 41, 83

- Safety of radium 19, 43, 74, 78, 88, 110, 111
- Of Roentgen rays 110
- Scarlet fever 68, 71
- School children, loss of time by 70

- Secondary radiations 41
Singers and speakers 73
Skin, applying radium to tonsils through 87
 Cancer 28, 29
 Diseases of 12, 24
 Lesions 24, 25
Slack, Dr. F. H. 68, 69
Stop watch for timing exposures 81, 82
Submerged tonsils 97
Suitable radiations, selection of 6, 19, 43, 44, 50, 56, 76, 78, 111
Superficial lesions, method of using radium for 22, 23
 New growths 12, 24

Therapeutic action of gamma rays 8, 9
Timing exposures, stop watch for 81, 82
Tongue depressor 81
 New growths of 32
Tonsillectomies done in the United States in one year 67
Tonsillectomy and radium contrasted 74
 Radium treatment after 107

Tonsillotomy, radium treatment after 107
Tonsils as a source of infection 67, 68
 Discharge from 85, 86, 109
 Method of applying radium to 83
 New growths of 32
 Prevalence of infected 69, 70
 Other methods of applying radium to 110
 Submerged 97
 Treatment 83, 84, 86, 87
 Treatment in acute conditions 84, 85

Uranium 3, 4
Uveitis 48

Vacuum, measurements in 15, 16, 17

Warts and warty growths 24
Water as a standard for absorption by soft tissues 16, 55
Weak forms of radium 22
Wolbach, Dr. S. B. 49



